NASA

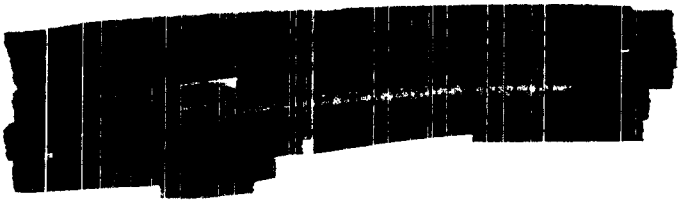
NASA TM-85415

RTOP

Research and Technology Objectives and Plans

Summary

Fiscal Year 1984
Research and Technology Program



INTRODUCTION

This publication represents the NASA research and technology program for FY 1984. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The *RTOP Summary* is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. We believe also that this publication can help to expedite the technology transfer process.

The *RTOP Summary* is arranged in five sections. The first section contains citations and abstracts of the RTOPs. Following this section are four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

The Subject Index is an alphabetical listing of the main subject headings by which the RTOPs have been identified.

The Technical Monitor Index is an alphabetical listing of the names of individuals responsible for the RTOP.

The Responsible NASA Organization Index is an alphabetical listing of the NASA organizations which developed the RTOPs contained in the Journal.

The RTOP Number Index provides a cross-index from the RTOP number assigned by the NASA responsible organization to the corresponding accession number assigned sequentially to the RTOPs in *RTOP Summary.*

As indicated above, responsible technical monitors are listed on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contact which might be disruptive to ongoing research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the *RTOP Summary* would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration
Office of Aeronautics and Space Technology
Washington, D.C. 20546
Attn: Edmund L. Sanchez, Acting Director
Resources and Management Systems Division (RM)

John Martin
Associate Administrator for
Aeronautics and Space Technology

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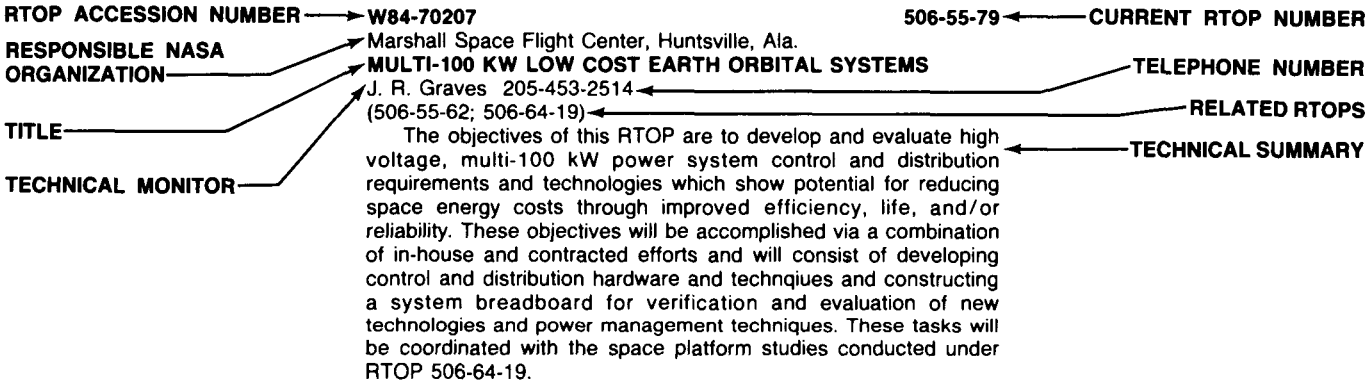


RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS

a summary

FISCAL YEAR 1984

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics Research and Technology Base

Fluid and Thermal Physics Research and Technology

W84-70001 **505-31-01**

Ames Research Center, Moffett Field, Calif.

COMPUTATIONAL METHODS AND APPLICATIONS IN FLUID DYNAMICS

V. L. Peterson 415-965-5265

(505-31-21; 506-51-11; 505-37-01)

The objective is to develop the capability for predicting complete aerodynamic characteristics of given aircraft and missile shapes and for designing new configurations aerodynamically optimized for specific missions to a degree that preliminary concepts can be developed, evaluated, and screened with less time, cost, and wind tunnel testing. New numerical methods, languages, and compilers will be constructed to realize the most effective use of available computer resources. Computer programs will be developed to simulate turbulence and to solve fluid dynamics problems for the complete spectrum of flight speeds from low subsonic, transonic, to hypersonic speeds, and for steady and unsteady, inviscid and viscous flow over two- and three-dimensional complex configurations. Fundamental experiments will be performed to verify these codes and to provide the necessary turbulence models. The Reynolds number domain will extend from conventional wind tunnel conditions to full scale flight conditions for present and future flight vehicles. Transfer of advanced computational aerodynamics technology to the aerospace community will be implemented by developing and disseminating computer codes appliable to practical aerodynamics problems.

W84-70002 **505-31-02**

Lewis Research Center, Cleveland, Ohio.

COMPUTATIONAL FLUID MECHANICS FOR TURBOMACHINERY

J. J. Adamczyk 216-433-5518

The objective of the computational fluid mechanics program for turbomachinery is to develop understanding and modeling ability for fundamental internal flow performance, and to develop computational analyses to simulate and predict the steady and unsteady flow conditions in advanced fans and compressors, cooled turbines, and advanced propellers. The computational methods are developed into practical codes for use on NASA and industrial computers. The broad objective of the computational fluid dynamic program in inlets, nozzles and mixers is to develop advanced, reliable, and user oriented computer design techniques and encourage their transfer into the general user community. This program is four-fold in nature, namely (1) develop effective methods of computing three dimensional viscous flows, (2) ensure reasonable agreement between said analyses and selective sets of benchmark verification data for reliable application, (3) develop 'user' orientation into these computer analyses for easier application and, (4) explore and develop improved numerical methodology as applied to advanced vector computers for more cost effective operation.

W84-70003 **505-31-03**

Langley Research Center, Hampton, Va.

COMPUTATIONAL AND ANALYTICAL FLUID DYNAMICS

P. J. Bobbitt 804-865-2961

(505-31-13; 505-31-23; 505-31-53)

The purpose of this research is to provide the fundamental computational methods required for calculating complete aerodynamic characteristics of complex aircraft shapes and for optimizing aircraft shapes for a given mission. The primary emphasis will be basic research in numerical and analytical methods coupled with large-scale computers. Research includes viscous and inviscid flow methods for all speed ranges. The main interest is in large, nonlinear problems; studies include acceleration of iterative methods for large systems of finite-difference equations, processor computers such as CYBER 203 and CRAY.

W84-70004 **505-31-11**

Ames Research Center, Moffett Field, Calif.

VISCOUS FLOWS

C. Thomas Snyder 415-965-5066

The objective is to acquire a sufficient understanding of viscous flows to permit the use of rational analysis methods in the design process. To support the above, detailed experimental data and economical computational schemes for turbulence modeling, data interpretation, and the development of design tools are required. Emphasis is placed on obtaining experimental data in terms of both man flow quantities and turbulence parameters using pressure instrumentation, hot wires, and optical devices in the 6- by 6-foot, 7- by 10-foot wind tunnels and various small scale research facilities. Such data will be used to guide the development of mathematical models for turbulent structures. These mathemtical models will subsequently be used to develop fast, efficient methods for the prediction of both attached and separated turbulent flows.

W84-70005 **505-31-13**

Langley Research Center, Hampton, Va.

VISCOUS DRAG REDUCTION AND CONTROL

R. V. Harris, Jr. 804-865-2658

The objective is to significantly improve our ability to predict and control the behavior of turbulent shear flows including boundary layers, free shear layers and recirculating/vortex flows. Theoretical and experimental research to (1) reduce turbulent skin friction drag, (2) control stream disturbances in supersonic and hypersonic tunnels, (3) determine sensitivities of boundary layer transition process to stream disturbance, and (4) improve understanding of

physics/structure of turbulent shear flows and turbulence modeling for computational fluid dynamics. Drag reduction research investigates nonplanar geometries such as riblets, large eddy breakup devices, convex curvature, long wavelength surfaces, Emmons spot alteration, large eddy substitutions, slot injection, fuselage relaminarization, and ion wind concepts, primarily for eventual CTOL transport application. Free stream disturbance research develops stagnation chamber treatments and laminar flow and rapid expansion nozzles to improve validity of wind tunnel measurements, especially for data where transition and flow separation are present. Detailed boundary layer transition studies with controlled input disturbances determine sensitivity of transition process to operational factors such as engine noise and surface irregularities. Detailed experiments using hot wires, LV and resonant Doppler systems provide data for development and validation of turbulence closure models in three-dimensional boundary layers, three-dimensional free mixing, corner/recirculating/vortex flows and shock-turbulence interaction/amplification. A unique technique for real-time and 3-space turbulence measurements is developed (i.e., holographic velocimeter). Diagnostic turbulence research provides data for invention and optimization of vortex and separation control techniques for form drag reduction and quantification of the effects of compressibility upon shear flow turbulence.

W84-70006 **505-31-15**
Jet Propulsion Laboratory, Pasadena, Calif.
BOUNDARY-LAYER STABILITY AND TRANSITION RESEARCH
L. M. Mack 213-354-2138

Knowledge of where laminar-turbulent transition will occur is important for accurate drag calculations, and a significant reduction in total drag is possible if transition can be delayed by passive or active means. At present it is not possible to make a rational prediction of if and where transition will occur because the relationship between transition and the disturbances that cause it is not known. It is the purpose of the work described in this RTOP to investigate experimentally and theoretically the production of instability waves by external disturbance sources (receptivity problem) and the propagation of the resultant wave packets and wave trains in two and three dimensional boundary layers, and to develop a rational method for the prediction of transition. In the experimental work, emphasis is placed upon the receptivity problem. An ongoing investigation demonstrated that weak freestream turbulence induces discrete wave packets within a zero pressure gradient boundary layer. The streamwise increase in the number of wave packets and the energy growth of each is examined by means of a sensor array and conditional sampling techniques. This work will contribute to improved transition prediction methods. Also, studies on wave propagation behind controlled sources will be continued as necessary for the interpretation of wave-packet results. The theoretical program is closely coordinated with the experiments. The harmonic and pulsed point-source initial-value problems are solved both by direct numerical integration and by the method of steepest descent as genaralized by Gaster for growing boundary layers. The wave motion downstream of discrete arrays of point sources and of finite-length line sources is obtained from the superposition of point-source solutions. A model for the receptivity problem will be developed on the basis of the experimental findings. The long-term objective is to combine the results of the wave propagation and receptivity investigation in a method for transition prediction.

W84-70007 **505-31-21**
Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL/THEORETICAL AERODYNAMICS
T. J. Gregory 415-965-5881

The objective of this research is to expand the aerodynamic technology base and provide a basic understanding of the aerodynamic flow fields about complete aircraft configurations, as well as individual components through the angle-of-attack range and from subsonic through supersonic Mach numbers. This includes ground based testing, flight experiments, and the application and development of theoretical prediction methods. Elements of this research are: (1) develop a computer structure for theory/experiment integration; (2) develop an advanced panel code (PAN AIR); (3) develop a transonic wing-body-tail code and three dimensional transonic wing design codes; (4) develop a carefully documented data base of transonic viscous flows over modern wings; (5) develop prediction techniques for unsteady flows; (6) conduct investigations of three dimensional bodies at high angles-of-attack; (7) develop a subsonic aerodynamic analysis code (VSAERO); (8) conduct experimental and analytical studies of aircraft trailing wake vortex flows; and (9) conduct flight experiments which are complementary to the analytical and wind tunnel research programs.

W84-70008 **505-31-23**
Langley Research Center, Hampton, Va.
EXPERIMENTAL AND APPLIED AERODYNAMICS
P. J. Bobbitt 804-865-2961
(505-31-53)

The objective of this research is to provide the fundamental data base needed for efficient design of advanced aircraft and for development of aerodynamic prediction techniques. In-house, contract and grant research will be used to advance the state-of-the-art with regard to: (1) advanced airfoils and airfoil research facilities; (2) understanding the structure of and attenuation techniques for aircraft wake vortices; (3) transonic cruise and maneuver aerodynamics for the design of wings and generalized aircraft configurations; (4) boundary layer transition disturbances; (5) understanding of laminar flow control technology; (6) non-intrusive laser velocity measurements in research model flow fields; and (7) design procedures for maneuvering supersonic aircraft.

W84-70009 **505-31-32**
Lewis Research Center, Cleveland, Ohio.
FLUID MECHANICS OF TURBOMACHINERY/LEWIS
L. D. Nichols 216-433-6906

The objective is to develop understanding of fluid mechanics of turbomachinery to improve performance and reduce design costs. Increased emphasis is placed on experiments to understand internal flows and analysis codes to improve turbomachinery design systems. The information will be used to improve the efficiency, operating range, distortion tolerance, durability and reliability and to reduce weight, volume, and cost of the turbomachinery systems. Understanding of the unsteady aerodynamic forces under various flutter conditions will be obtained and codes developed and verified to be able to avoid the occurrence of flutter and minimize the effects of aerodynamic forcing terms. Understanding of the steady and unsteady aerodynamic forces pertinent to noise generating mechanisms of turboprops and turbomachinery components will be developed based upon experimental results and models validated to predict noise generation and provide a means for its reduction. Understanding of the effects of exciting fluid mechanic instabilities which occur in turbomachinery shear and boundary layers will be developed to determine the extent which they may be exploited to influence turbomachinery performance. The work is conducted through in-house, contract and grant efforts.

W84-70010 **505-31-33**
Langley Research Center, Hampton, Va.
AEROACOUSTICS RESEARCH
H. G. Morgan 804-865-3577
(505-33-53; 505-35-13; 505-42-23; 532-06-13)

The objective of this aeroacoustics research RTOP is understanding and predicting the generation and propagation of noise due to fluid flows associated with aircraft propulsion systems and then reducing or controlling the noise with minimum weight, performance, and economic penalties. Analytical, computational, and experimental approaches are included in research that is conducted in-house and by grant and contract. Improved understanding of the mechanisms by which fluid flows generate noise is sought, and theories and validating data bases for accurate prediction and noise reduction are developed. The experimental portion of the program emphasizes laboratory studies under controlled conditions, supplemented by flight tests where appropriate. The problem areas upon which the program is focused are

subsonic and supersonic jet exhaust noise, duct acoustics and liner technology, and atmospheric propagation.

W84-70011 **505-31-41**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL FLAME RADIATION RESEARCH
R. L. Jaffe 415-965-6458

The objectives are to provide an in-depth, theoretical understanding of both combustion processes and spectroscopic techniques for non-intrusive, laser-based flame diagnostic measurements. The research will be coordinated with several experimental programs at LaRC, LeRC, and ARC which are not part of this RTOP. The approach will utilize first principles calculations of the fundamental, spectroscopic, thermodynamic, and chemical kinetic properties, if they are not well known, of molecules which have important roles in combustion processes. These data will be coupled with the results from numerical flame structure models to produce synthetic spectra which can be compared to experimental and theoretical spectra taken under identical conditions. Significant differences between the experimental and theoretical spectra would indicate deficiencies in the numerical model which would then be improved until agreement is attained. Consequently, this research will lead to the establishment of a validated combustion model which is capable of reliably predicting flame properties. The theoretical molecular property data will also be used to synthesize cross sections for spectroscopic transitions which can be used for diagnostic measurements of flame temperature and composition. This research will help identify new non-intrusive analytical techniques for combustion experiments and add to the effectiveness of existing diagnostic methods.

W84-70012 **505-31-42**
Lewis Research Center, Cleveland, Ohio.
BURNING FUNDAMENTALS AND HEAT TRANSFER
R. A. Rudey 216-433-6625
(505-40-22; 533-04-12; 535-05-12)

The objective of the Combustion and Heat Transfer Research Program is to provide technology for advanced combustion systems, turbine systems and aircraft fuel systems for future civil and military applications aimed at improving performance, durability, and reliability while achieving fuel flexibility and reduced emissions. This is to be accomplished by establishing a more complete and basic understanding of fundamental combustion and heat transfer phenomena typical of gas turbine engines and to support the development of advanced computational techniques for accurately characterizing the governing aerothermodynamic processes. The effort is focused on (1) developing a fundamental knowledge and understanding of the characteristics and effects of potential alternative fuels, (2) achieving a basic understanding and analytical representation of the fundamental aerodynamic and chemical kinetic phenomena governing the combustion process, (3) developing analytical models for predicting the internal aerothermodynamic performance of combustors, turbines and fuel systems, and (4) developing analytical models for predicting thermodynamic and transport properties and chemical reaction rates for hydrocarbon fuels. The program includes both fundamental and applied research activities conducted in-house, under grants to universities, and under contracts to industry. Overall coordination with other government agencies, such as DOD, DOE, DOT, EPA, and with industry is maintained in order to provide the proper direction and scope to the program.

W84-70013 **505-31-51**
Ames Research Center, Moffett Field, Calif.
TEST METHODS AND INSTRUMENTATION
G. Lee 415-965-5861

The general objective of this research is to provide the technology for increased aerodynamic experimental research capability required to improve prediction of performance and flight characteristics of conceptual or new aircraft designs and the exploration of advanced aerodynamic concepts. This includes both ground-based and flight test capability improvements. Flow quality, measurement of model attitude and deformation, minimization or elimination of wind tunnel wall constraint effects, and means for simulating higher Reynolds number flows will be investigated analytically and experimentally to improve the quality of test results. Advanced laser velocimeter and holographic interferometric instrumentation systems will be developed to obtain fundamental fluid mechanic measurements such as mean velocities, turbulence intensities, densities, and Reynolds stress components. This research work will include an air data inertially-based integrated sensor, miniature multichannel pressure system, a high accuracy fuel flow meter and an airborne laser Doppler velocimeter, to improve flight test capabilities.

W84-70014 **505-31-52**
Lewis Research Center, Cleveland, Ohio.
PROPULSION INSTRUMENTATION
N. C. Wenger 216-433-6646

The objective of this RTOP is to develop sensors and measurement systems that have application in studies of fundamental phenomena, in component research and development, and in full-scale engine experimentation and testing. Part of the effort is focused on developing miniature minimally intrusive sensors for measuring temperature, heat flux, and strain in a wide variety of applications. The balance of the effort is directed at research on nonintrusive measurement systems, usually employing lasers, for the measurements of strain, gas flows, combustion gas species and temperature, and smoke parameters. This effort is closely coordinated with the development of bench mark experiments where critical measurements are required to determine the validity and accuracy of various types of fluid mechanic, combustion, and structural models and computer codes that are currently under development.

W84-70015 **505-31-53**
Langley Research Center, Hampton, Va.
EXPERIMENTAL TEST TECHNIQUES
P. J. Bobbitt 804-865-2961
(505-31-23)

The technical objective is to provide the technology for increased ground based aerodynamic experimental reseach capability and to develop the specific test technology required to fully exploit the unique capabilities of the new pressurized cryogenic wind tunnels in the performance of research and development studies related to advanced aerodynamic test concepts at full scale Reynolds numbers. This objective will be accomplished utilizing in-house, contract, and grant research to: (1) extend development of cryogenic technology and full-scale Reynolds number test techniques; (2) continue development of technology required for engineering of models for the high pressure cryogenic environment; (3) provide instrumentation capable of operating over a wide temperature range with emphasis on minimizing measurement error and time required for data collection; (4) develop advanced nonintrusive measurement technology; (5) advance the state-of-the-art of experimental methods including transonic tunnel wall interference effects and magnetic suspension and balance systems; and (6) provide operational support in terms of liquid nitrogen and staffing the National Transonic Facility.

W84-70016 **505-31-55**
Jet Propulsion Laboratory, Pasadena, Calif.
THREE-DIMENSIONAL VELOCITY FIELD MEASUREMENT
V. Sarohia 213-354-6758

The objective of the effort is to develop and validate a new technique for the rapid and automatic mapping of the three-dimensional velocity field in liquid and air flow. The technique is based on the use of luminescent particles excited by accurately aimed laser beams. The experiments will be performed in a water channel and in a wnd tunnel on a simple, well-defined flow over an airfoil or a cylinder to prove the concept and to determine the accuracy of this novel technique. Both still and motion pictures of the flow illuminated by laser beams located at preselected points will be taken. The three-dimensional flow will be quantified and the velocity field will be derived using the digital image analysis

techniques developed in the Fluid and Thermal Sciences Laboratories at JPL.

W84-70017 **505-31-83**
Langley Research Center, Hampton, Va.
MATHEMATICS FOR ENGINEERING AND SCIENCE
Robert H. Tolson 804-865-2664

The objective of this RTOP is to provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments. The research is carried out by a combination of in-house efforts, university research grants, and the continuing operation of the Institute for Computer Applications in Science and Engineering (ICASE) located at the Langley Research Center. The in-house and grant efforts include research dealing with geometry modeling, grid generations, and numerical solutions of differential and algebraic systems and visualization of computed results. The broad research areas pursued in ICASE include: numerical analysis with particular emphasis on the development and analysis of basic numerical algorithms; computational research in engineering and science in selected research areas of concern to the Langley Research Center, including fluid dynamics, structural analysis, acoustics, guidance and control, and other appropriate areas; and computer systems and software, such as advanced computers, microprocessors, and parallel systems.

Materials and Structures Research and Technology

W84-70018 **505-33-10**
National Aeronautics and Space Administration, Washington, D.C.
RESEARCH IN ADVANCED MATERIAL CONCEPTS FOR AERONAUTICS
Michael A. Greenfield 202-755-3277

The objective is to conduct fundamental research on advanced material concepts for aeronautics. The interdisciplinary program in polymeric composites includes research into the properties of the constituent fibers and matrix properties, advanced structural analysis methods, fatigue response of laminates, environmental response modeling and processing science for light weight airframe structures. The interdisciplinary project in ceramic materials addresses critical research in material performance and design methodology as related to brittle materials. Emphasis is to be placed on understanding the processing and properties of these materials. Activities include fundamental characterization of silicon nitride and silicon carbide materials, environmental response processing science and impact behavior of high temperature ceramic bodies for gas turbine engine application. Advisory services to guide R and D in advanced aerospace materials are provided by the National Materials Advisory Board, a unit of the National Academies of Science and Engineering.

W84-70019 **505-33-12**
Lewis Research Center, Cleveland, Ohio.
HIGH TEMPERATURE MATERIALS
C. E. Lowell 216-433-6922
(505-33-32; 506-53-12; 533-04-12)

The major objective of this RTOP is to advance the level of materials and processing technologies for high-temperature metallic and ceramic materials in order to contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines. The prime emphasis of the work is directed toward developing greater understanding of the interrelationships between material composition/microstructure, fabrication processes, and mechanical/physical properties. Such understanding will serve to guide the creation of advanced materials concepts and options for future higher performance/higher durability/lower cost aircraft propulsion system components. Research includes basic studies aimed at understanding the influence on microstructure/properties of reductions in and substitute elements for critical metals in superalloys (Co, Ta, Nb, Cr) as well as identification of potential iron-base alloy or aluminide replacements for superalloys. This is supplemented by basic research on ceramics/ceramic composites. Further basic studies focus on the interactions between phase composition/distribution and advanced fabrication process variables for cast/wrought/powder metals and ceramics and include rapid solidification technology (melting spinning). Also, fundamental studies of potential service environment attack (oxidation/hot corrosion/etc.) are conducted in controlled and simulated engine environments to guide and support basic and applied research on the identification and validation of advanced metallic and thermal barrier coating concepts. Tribology research aims at understanding material/lubrication/wear interaction fundamentals.

W84-70020 **505-33-13**
Langley Research Center, Hampton, Va.
ADVANCED STRUCTURAL ALLOYS
R. C. Goetz 804-865-2042
(505-33-23; 505-43-43)

The objectives of this research are focused on understanding the metallurgical structure/mechanical property relationships characteristic of advanced structural alloys. This understanding is expected to provide a basis for new or improved concepts to achieve more efficient structural alloys for future aircraft applications. Current research includes fundamental studies of the structure/property relationships in advanced PM aluminum alloys as they relate either to alloy chemistry thermomechanical treatments, or aging behavior; and the development of new/improved processing methods to provide a basis to achieve more efficient structural shapes. Research in advanced PM aluminum alloys will include optimizing powder processing techniques, alloy chemistry, and thermomechanical treatments based on a fundamental understanding of the metallurgical features desirable for high performance applications. Research in processing technology will emphasize SPF of advanced aluminum alloys to achieve unique and highly efficient structural shapes, SPF effects on microstructure and mechanical properties will be characterized. Adaptability of the SPF process to advanced PM aluminum alloys will be explored.

W84-70021 **505-33-21**
Ames Research Center, Moffett Field, Calif.
FATIGUE DAMAGE AND ENVIRONMENTAL EFFECTS IN METALS AND COMPOSITES
H. G. Nelson 415-965-6137

A combined experimental and analytical program will continue in an effort to characterize and better understand the fatigue and fracture behavior of both metallic and composite (graphite/epoxy) materials used or anticipated to be used in airframe structures. Additionally, the knowledge will be applied where practicable to help solve existing engineering problems and to improve life prediction procedures of real aerospace structures. For metallic materials, crack initiation and subcritical crack growth stages of fracture are being characterized using a fracture mechanics approach. Our primary objective is to understand the influences of the chemical environment on fracture behavior in order that we may predict the stress corrosion and corrosion fatigue behavior of aerospace structural materials including advanced P/M aluminum alloys. Considerable emphasis is placed upon understanding the kinetic aspects of embrittlement and in particular the importance of surfaces and surface reactions. For composite materials, a modified time-temperature superposition approach is used to establish correspondence between stress, moisture, temperature, and time as these variables influence the durability of complex graphite/epoxy laminates. It is our aim to develop the methodology required to obtain accurate constitutive relationships such that improved accelerated test procedures and life prediction techniques can be applied to real aerospace composite structures. The scope has been changed to reduce emphasis on composites.

W84-70022 **505-33-22**
Lewis Research Center, Cleveland, Ohio.
LIFE PREDICTION FOR ENGINE MATERIALS
Marvin H. Hirschberg 216-433-4000

The objective is to advance quantitative life prediction capabilities applicable to high temperature aerospace propulsion system components, thereby enabling considerable improvement in durability as well as operating and maintenance efficiency to be realized. A combined experimental, analytical, and theoretical approach is applied to the development of creep-fatigue viscoplastic flow and life prediction models for advanced high temperature materials systems. The models incorporate thermal, mechanical and environmental damage contributions. The application of fracture mechanics is extended to ceramic materials and small crack behavior addressing advanced material concerns and crack growth rates immediately following initiation. Observed mechanisms of damage cumulation leading to crack initiation and propagation under complex high temperature mechanical and thermomechanical loading provide a physical basis for development of quantitative concepts to be used in life prediction models. These life prediction models are to be verified through benchmark tests and ultimately incorporated into analytical codes that are applicable to complex structures.

W84-70023 **505-33-23**
Langley Research Center, Hampton, Va.
LIFE PREDICTION FOR STRUCTURAL MATERIALS
R. C. Goetz 804-865-2042
(505-33-13; 505-33-33; 506-53-23)

The objectives of this research are to understand the fatigue and fracture behavior of experimental and engineering materials and to develop reliable life prediction techniques that are applicable to the use of these materials in aircraft structures. Formulation of a theoretical framework for life prediction and experimental validation of the theoretical concepts involved form a major part of this research focus. Characterization of the integrity of structural materials by nondestructive techniques is also included. The nondestructive materials research involves both theoretical modeling and experimental verification of advanced ultrasonic/acoustic phenomena as related to understanding fundamental material properties and behavior under complex loads. Research in fatigue and fracture includes structural alloys as well as thick-section, polymeric composites. In depth analyses of the fracture and crack-growth processes will be conducted and comparisons made to validate and extend the reliability of current life prediction models. Nondestructive materials research will focus on providing a scientific basis for quantitative ultrasonic analysis of the integrity and properties of composites and metals. Precision measurement techniques to determine the physical mechanism of materials behavior such as the mechanics of impact damage in composites will constitute a significant part of the nondestructive materials research.

W84-70024 **505-33-31**
Ames Research Center, Moffett Field, Calif.
POLYMERS FOR LAMINATED AND FILAMENT-WOUND COMPOSITES
J. A. Parker 415-965-5225
(505-45-11; 534-03-13)

The objective is to synthesize, characterize and evaluate new and improved matrix resins for application in composite aircraft structures and/or filament-wound systems. A further objective is to develop molecular design criteria for new resins for such applications. Resins will be sought having high strength, impact resistance, thermal stability, fire resistance, easy processing and curability, and imparting desired mechanical properties and cost effectiveness to fiber-reinforced composite structures. The basic chemistry of candidate new resins will be studied with respect to the kinetics and mechanisms for polymerization, chain extension, and/or crosslinking (curing), and thermal, oxidative and hydrolytic degradation. The search for improvements over state-of-the-art resins will involve appropriate structure-property correlations and the preparation of prepolymers (oligomers) through chain extension and curing of such compounds as bismaleimides, stilbazoles, vinyl-terminated styryl pyridine oligomers, and perhaps also perfluoroalkylaryl monomers.

W84-70025 **505-33-32**
Lewis Research Center, Cleveland, Ohio.
HIGH TEMPERATURE ENGINE COMPOSITES
H. B. Probst 216-433-4000

The overall objective of this research is to identify and evolve composite materials and processing technology with potential for aero propulsion components having lower weight, higher use temperature, higher strength, reduced cost and greater reliability. A wide range of matrix materials is under investigation including polymers, metals, and ceramics. In the area of polymer matrix composites, emphasis is placed on synthesis of high temperature matrix resins for use at 370 C, improved toughness PMR polyimides, high temperature adhesives, and on fundamental studies of polymer cure/degradation mechanisms. In metal matrix composites, emphasis is placed on improving key properties of high temperature composite systems as well as on understanding how these materials fail and degrade so as to overcome their deficiencies. In ceramic matrix composites, studies are devoted to polymeric precusors which will give high temperature ceramic matrices. Micromechanics of composite systems are under study to eventually develop a modeling capability to predict strength and toughness.

W84-70026 **505-33-33**
Langley Research Center, Hampton, Va.
COMPOSITES FOR AIRFRAME STRUCTURES
R. C. Goetz 804-865-2042
(505-33-23; 506-53-23; 534-06-23)

The objective is to achieve the full weight reduction potential of highly loaded composite structures. The approach is to improve matrix properties, damage tolerant concepts, analytical predictive methods, and understanding of aging effects. Structural resins and adhesives with improved toughness, moisture resistance, processability, and thermal performance will be synthesized. Fundamental factors which control toughness and damage tolerance in resins and composites will be determined. Impact damage and residual strength will be measured and modeled mathematically. The effectiveness of bolted composite joints and woven buffer strips will be studied. Using advanced structural concepts and design methods, flat, curved, and stiffened structures will be made and tested in compression, tension, combined loads, and after damage. Analytical methods will be developed to predict properties. Long-term durability under expected service environments will be studied using ground-based and flight service exposure. Predictive analytical methods for environmental effects will be developed with emphasis on verification of accelerated test methods. Analyses for describing the nonlinear behavior of structures including postbuckling and ultimate strength will be developed. Processing methods for new resin systems will be established with emphasis on economics and consistent quality. Resin rheology and cure mechanics studies will be used as the basis for developing cure processes.

W84-70027 **505-33-41**
Ames Research Center, Moffett Field, Calif.
FLIGHT LOAD ANALYSIS
A. L. Carter 805-258-3255

This RTOP has five primary purposes: (1) to study flight airload and deflection measurement techniques on flexible, flight test vehicles; (2) correlate flight measured and predicted buffet for the TACT aircraft; (3) develop and verify flight loads analysis methods for flight testing applications, using flight test data; (4) develop flight flutter test techniques under R&D contracts and verify using flight test data; and (5) advance analytical techniques/operational capability for dynamic finite element solutions in areas of free and damped vibrations, aeroservoelastics and flutter.

W84-70028 **505-33-42**
Lewis Research Center, Cleveland, Ohio.
ENGINE DYNAMICS AND AEROELASTICITY
L. Berke 216-433-4000

The primary objective of this program is to develop and experimentally validate improved analytical methods to predict the

dynamic and aeroelastic response of aircraft turbine engine structures and of advanced turboprops. A secondary objective is to evaluate the effectiveness of vibration-reduction methods for bladed disks, such as mistuning and the use of damping materials and mechanisms. The approach to dynamic analysis will be to develop vibration analyses for engine structural systems and structural components that vary in complexity, cost-of-use and accuracy from the simplest analysis that captures the relevant physics to analyses capable of quantitative prediction. The mathematical models will take into account the interactions between components, including those at frictional interfaces. A comprehensive study of the internal degrees of freedom of these components will be made. Steady state and transient situations, such as blade loss, will be addressed. More thorough methods of predicting aeroelastic response of bladed disks, including advanced turboprops, will be developed that take advantage of the latest available computer capabilities and which include the effects of complex blade shape, cascade interactions, mechanical coupling between blades, mistuning, transonic and 3-D aerodynamics, loading and geometric nonlinearity. Experimental study of engine dynamic phenomena and experimental verification of the development mathematical models is a critical aspect of this program.

W84-70029 **505-33-43**
Langley Research Center, Hampton, Va.
LOADS AND AEROELASTICITY
R. C. Goetz 804-865-2042

The objective is to develop and validate improved methods for analytically determining loads, structural response, and structural stability of aerospace systems considering the dynamic and aeroelastic characteristics of the systems and structural interactions with flight control sub-systems, and to use these methods in the development and evaluation of techniques for eliminating or minimizing flutter, buffet, and other undesirable response phenomena, and for the enhancement of performance, ride quality, and service life. Research will be conducted to provide more accurate unsteady aerodynamic theories, particularly in the transonic range. The capability for design of multi-functional active control systems will be expanded. Advanced aeroelastic analysis methods will be evaluated and validated by both wind tunnel tests and flight tests using the DAST concept (Drones for Aerodynamic and Structural Testing). Emphasis will be on measurements of transonic aerodynamic loads, and flight validation of active control systems for load alleviation and flutter suppression. A decoupler-pylon concept for wing store flutter suppression will be evaluated in flight tests on a fighter airplane. Basic wind tunnel flutter studies will be used to gain a better understanding of the flutter characteristics of advanced aerodynamic configurations. The obsolete dynamic Data Acquisition System of the LaRC Transonic Dynamics Tunnel will be replaced with modern hardware and appropriate software to allow efficient operation of the tunnel.

W84-70030 **505-33-52**
Lewis Research Center, Cleveland, Ohio.
ENGINE STRUCTURES AND DYNAMICS
D. J. Gaunter 216-433-4000

The objective of this program is to develop and verify advanced analysis and synthesis methods and advanced generic structural concepts for turbine engine components. Emphasis will be on high temperature applications. Material behavior constitutive relations will be developed emphasizing anisotropy of DS, single crystal and composite materials. Generic structural concepts will be conceived to exploit the capabilities of advanced material systems. The approach emphasizes development of new anisotropic nonlinear finite element thermostructural analysis methods. Another objective of this work is to advance the state-of-the-art in mechanical components such as shaft seals, gas path seals, shafts and rotors, and dampers. Goals are to achieve improved component performance, life, reliability and efficiency in the severe temperature, speed and pressure environments of turbine engines and transmission systems. Innovative mechanisms and techniques for determining and controlling the dynamic behavior of rotating assemblies (shafts and rotors, dampers, seals and aerodynamic components) will be analyzed, created or formulated and corroborated experimentally to enhance the performance of high speed rotating machinery.

W84-70031 **505-33-53**
Langley Research Center, Hampton, Va.
ADVANCED AIRCRAFT STRUCTURES AND DYNAMICS RESEARCH
R. C. Goetz 804-865-2042

Structural analysis and sizing methods will be developed for aerospace structures. Particular attention will be paid to nonlinear behavior such as postbuckling phenomena and ultimate strength of composite structures. An inter-disciplinary research team (PICASSO) will continue development of integrated analysis and synthesis methods and associated computer software. In-house test procedures will be developed and tests conducted to measure the response of composite structural components under crash conditions. Test articles requiring special tooling will be fabricated under contract. Preparations for full-scale crash test of a B-720 aircraft will continue in cooperation with Ames (Dryden) and FAA. Structural concepts and thermal management techniques will be developed and evaluated for application to airframes and engines of aircraft which cruise in supersonic to hypersonic regime. Practical concepts for alternate Mach numbers and oxygen enrichment in the 8' high temperature structures tunnel will be developed and verified. Improved methods of analysis for noise in aircraft cabins and techniques for minimizing noise transmission to enhance ride quality will be developed. Research encompasses in-house laboratory studies and out-of-house analysis and experiments on aircraft and model cylinders.

Controls and Guidance Research and Technology

W84-70032 **505-34-01**
Ames Research Center, Moffett Field, Calif.
FLIGHT CONTROL CONCEPTS AND RELIABILITY ENHANCEMENT
J. A. Franklin 415-965-5009
(505-34-11; 505-34-03; 505-42-11)

Research in advanced control technology will be pursued to develop the technology base for design of reliable, flight crucial control systems for aircraft and aerospace craft that provide improved operational capabilities over these vehicles' flight envelopes. Analytical studies will be conducted to investigate concepts and methodoloy. Ground-based simulation and flight experiments will be carried out to substantiate the methodology. Nonlinear inverse system concepts and optimal control methods will be employed for vehicles that exhibit significant aerodynamic and kinematic non-linearities and control redundancy. Fly-by-wire control, fault-tolerant microcomputer and actuation system concepts will be explored for the purpose of enhancing control reliability. Flying qualities design requirements for super augmented aircraft will be defined and automated control concepts developed such as for air combat missions. University grants will be awarded to support promising research in the field and to keep NASA abreast of new advances in control theory pertinent to analysis and synthesis of reliable flight control systems.

W84-70033 **505-34-02**
Lewis Research Center, Cleveland, Ohio.
CONTROL THEORY AND METHODOLOGY
F. Teren 216-433-4000

The objective is to provide an improved technology base for future engine control system development through the development of advanced multivariable control theory and methodology, and reliable fault-tolerant distributed controls. Multivariable control design techniques are developed and applied using time and frequency domain methods. Sensor failure detection, isolation and accommodation algorithms are developed for single and multiple engine applications. The latest VLSI circuitry techniques are utilized

in multiple-processor fault-tolerant full-authority electronic propulsion control architectures. Both software and hardware technologies are pursued.

W84-70034 **505-34-03**
Langley Research Center, Hampton, Va.
AIRCRAFT CONTROLS: THEORY AND APPLICATIONS
J. R. Elliott 804-865-4681

NASA has a primary national responsibility and plays a major role in the area of flight control research and technology innovations and development. Increasing reliance is being placed on controls technology during the design process. Thus, a continuing activity of investigation, development, and validation of advanced stability, control and guidance concepts which will permit the control system designer to adequately cope with the increasingly complex demands of modern aircraft control system designs is required. The objectives of this RTOP are to establish guidelines and criteria for designing full-authority control systems for highly augmented aircraft; to devise and validate methodology for the integrated design of advanced flight control systems; and to conceive and validate advanced theoretical concepts for control of aircraft and their trajectories. The research to be conducted is an effort towards fulfilling the need to maintain the U.S. in a competitive position in the stability, control and guidance disciplines applied to highly augmented civil and military aircraft. Aircraft flying qualities and control system design criteria research; advanced control theory and system identification procedures; computer program development and tecniques for computer-aided aircraft design processes; and mathematical modeling procedures and analysis/synthesis procedures for flexible aircraft with active controls will be pursued through in-house, contract, and grant studies with leading specialists. Research activities will encompass theoretical, simulation, and flight test studies.

W84-70035 **505-34-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED CONTROLS AND GUIDANCE
D. G. Denery 415-965-5427
(505-34-01; 532-01-11; 532-06-11; 505-45-11; 533-02-51)

The objective of this research is to develop a technology base for the design, validation, and assessment of flight crucial controls and to develop advanced guidance concepts for both civil and military missions. The work will be accomplished within three tasks: (1) the development, evaluation, and flight test of advanced flight control techniques utilizing the F-8 flight facility; (2) the development and evaluation of advanced verification and validation tools applicable to digital flight control systems; and (3) the development of theory and concepts for advanced guidance, navigation, and flight control and associated air traffic control as applied to both military and civilian missions. The approach will involve analysis, simulation, and experimentation. Task 1 will emphasize experimentation using the F-8 Flight and Iron-Bird Facility. Task 2 will emphasize simulation and experimentation using the DFCS Verification and Validation Laboratory. Task 3 will emphasize analysis and simulation. Task 1 and 2 involve industry participation while Task 3 is primarily an in-house activity augmented by University, IPA and NRC staff.

W84-70036 **505-34-13**
Langley Research Center, Hampton, Va.
ADVANCED NAVIGATION, GUIDANCE, AND CONTROL TECHNOLOGY
H. Milton Holt 804-865-3681

Aircraft and space vehicles of the 1990-2000 time period can be more efficient and profitable as a result of new technology advances. The acceptance of those advances can be accelerated by reducing the risk of the new technology. The objective of this effort is to develop a technology base for the design, validation, and assessment of flight-crucial controls and to develop advanced guidance concepts and crew station interface devices for improving aircraft and space vehicle flight path guidance. The approach is to develop the methodology for fully integrated flight-crucial controls and guidance functions; identify candidate system architectural concepts; establish a credible validation process for advanced digital system designs through the development of new assessment methods, emulation/simulation techniques, and physical testing techniques; develop theories and techniques to design and evaluate advanced flight path guidance and control systems; develop and integrate advanced display concepts, display media, and information input/output techniques; and investigate lightning environmental effects.

W84-70037 **505-34-17**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED INFORMATION PROCESSING SYSTEM (AIPS)
E. S. Chevers 713-483-2851
(936-67-01)

The goal of this program is the development and demonstration of a system architecture and the associated design and evaluation methodologies which will effectively serve the need for advanced information processing across a broad spectrum of future NASA missions. The output will be proof-of-concept demonstration of processing core with associated data and power distribution media that can be gracefully expanded to support various specific applications. The design methodology, hardware/software tradeoffs, modularity, and testing processes are significant elements of this output. A primary goal is to evaluate the system in a flight test environment. This evolutionary program will be accomplished over a 6-year period and have milestones which might be directed towards various applications. The basic program is intended to be generic in context, and utilize output from parallel programs as appropriate. The system will demonstrate high reliability with minimum maintenance costs.

W84-70038 **505-34-23**
Langley Research Center, Hampton, Va.
AIRLAB OPERATIONS
Dale G. Holden 804-865-3681
(505-34-13)

Operate, maintain, and enhance the role of AIRLAB as a major facility for conducting controls and guidance research. Provide descriptive system documentation and operational support to assist AIRLAB users in the study, evaluation, and demonstration of the safety, reliability and performance of fault-tolerant electronic systems for future aerospace applications. Maximize the utility and operating time of AIRLAB equipment by providing hardware and software maintenance support in an efficient and timely manner. Implement new or improved hardware and support software to enhance AIRLAB capabilities, improve ease of use, and increase productivity.

Human Factors Research and Technology

W84-70039 **505-35-10**
National Aeronautics and Space Administration, Washington, D.C.
SUPPORT FOR THE COMMITTEE ON HUMAN FACTORS OF THE NATIONAL ACADEMY OF SCIENCE
Melvin D. Montemerlo 202-755-3273

This RTOP provides support for NASA's joint sponsorship with the Office of Naval Research (ONR), the Army Research Institute (ARI), and the Air Force Office of Scientific Research (AFOSR), of the National Academy of Sciences' (NAS) Commission on Behavioral and Social Science (CBASS) Committee on Human Factors. The National Academy of Sciences and its committees provide advice to governmental agencies in solving advanced technological problems. The Committee on Human Factors was established to provide advice on determining the most important theoretical and methodological issues in human factors.

W84-70040 **505-35-11**
Ames Research Center, Moffett Field, Calif.
FLIGHT MANAGEMENT SYSTEMS
H. P. Klein 415-965-5094
(505-35-21; 505-35-51; 505-35-21)

An objective of this program is to develop the technology base for the interaction between the crew, cockpit, and air traffic control system; this technology base is required to improve operational performance, operational safety, and capacity. The program will be accomplished through a multi-pronged effort in areas related to man-system roles and interactions, advanced flight management systems concepts, cockpit display of traffic information, pilot-controller interactions, advanced information display concepts, pictographic displays, the role of operational avionics in training and proficiency maintenance, workload definition, workload measurement, and workload prediction. The effort will depend on the use of analytical studies, laboratory simulation, and the Man-Vehicle Systems Research Facility. It will be supported by contractor studies, university grants, and in-house contractor support.

W84-70041 **505-35-13**
Langley Research Center, Hampton, Va.
FLIGHT MANAGEMENT
S. A. Morello 804-865-3621

The objective of this program is the development of a technology base required for efficient operation in the current and future air transportation system, including technical integration of airborne systems with evolving ATC systems technology; definition of display factors, control concepts, and intelligent aids for optimizing the utilization of crew capabilities; development of operating procedures to improve safety, efficiency, and capacity; and development of methodologies for assessing crew performance and workload. The development of technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on aircraft crews and passengers is also an objective of this program. Simulation facilities and flight vehicles, equipped with appropriate displays will be operated in conjunction with a simulated ATC environment to represent flight operations in an advanced en-route and terminal area environment. Subjective laboratory studies, field research and impact assessments will be conducted in the research of human response to noise.

W84-70042 **505-35-21**
Ames Research Center, Moffett Field, Calif.
HUMAN PERFORMANCE AFFECTING AVIATION SAFETY
H. P. Klein 415-965-5094
(505-35-11; 505-35-31)

This reserch is designed to identify factors which cause or contribute to error in the aviation system, and to explore methods to prevent human error accidents by eliminating their causes or by minimizing the impact of such errors when they occur. The NASA aviation Safety Reporting System provides a basis for descriptive studies and other supporting data used to determine human and system factors associated with human error in aviation operations, and to identify potential solutions to these problems. Studies of pilot fatigue and circadian desynchronosis are being conducted to determine the extent to which these factors play a role in operational problems associated with human performance. Concurrent studies of pilot performance in full-mission simulation are designed to yield more objective measures of high-level cognitive and intellectual functioning than have heretofore been available, so that models of pilot performance and the effects of stresses, such as fatigue, can be developed.

W84-70043 **505-35-31**
Ames Research Center, Moffett Field, Calif.
PILOTED SIMULATION TECHNOLOGY
H. P. Klein 415-965-5094
(505-35-21; 505-42-11; 505-35-11)

The general objective of this research and development activity is to provide a scientific and technical base for developing valid, reliable, and economical simulators for aeronautical research, development, and crew training. Specific objectives are to: (1) develop human factors and engineering principles and validation techniques for guiding and evaluating the effective utilization of flight simulators, and (2) develop an understanding of the fundamental principles of sensory cueing in aircraft operation, and (3) investigate the influence of cueing and modeling techniques on man/vehicle system characteristics and pilot assessments in aircraft handling qualities simulations. These objectives will be met by evaluating the use of mission oriented simulation concepts for improving the effectiveness of simulation design and crew performance assessment; evaluating the man/vehicle characteristics of helicopter simulation models, and validating the models with in-flight simulation data; continuing research on critical parameters of optimal dynamic displays; evaluating the effects of motion and visual cue modeling and computation techniques on precision flight tasks.

W84-70044 **505-35-33**
Langley Research Center, Hampton, Va.
FLIGHT SIMULATION TECHNOLOGY
J. D. Shaughnessy 804-865-3917
(505-45-33)

The major objective of this RTOP is the development and application of a technology base that will permit the economical and reliable substitution of simulators for actual flight operations in support of Langley's flight management research programs. The program involves both in-house and contractual studies that are analytical and/or experimental in nature and address the issues of simulation design, environmental modeling, and validation. As part of the agency-wide program, Langley participates in those areas that naturally evolve from the traditional base interests of the Center. Chief among those interests is the recognition that the development of engineering and perceptual requirements for man-in-the-loop simulation is a complex task involving trade-offs between simulation fidelity and costs. In specifying the cue environment the designer must establish the need for particular cues as well as the requisite fidelity of presentation. Unfortunately, the decisions are quite difficult to make objectively, inasmuch as the choices depend on complex psychological as well as engineering factors. Particular emphasis will be placed at LaRC on several technical disciplines including vision/visual systems, man/vehicle performance assessment, atmospheric modeling, non-visual cue generation, and analytical techniques and models for analysis of man/machine systems.

W84-70045 **505-35-81**
Ames Research Center, Moffett Field, Calif.
OPERATION OF HUMAN FACTORS FACILITIES
F. J. Styles 415-965-5728

This RTOP provides for the operation, maintenance, modification and upgrade of the human factors research facilities at Ames Research Center. The Center conducts a variety of human factors research programs for NASA, DOD, FAA, industry and other Government agencies in areas of advanced concepts and operational problems of flight management systems, human factors in aviation safety, helicopter/VTOL human factors, workload/performance measurement, perception, and simulation and training technology. This research requires the utilization of both the small, relatively simple and flexible experimental setups, computers and cockpit simulators in Buildings N239 and N239A (the Human Factors Research Laboratories) and the highly sophisticated, full-system/full-mission flight simulators and supporting equipment of the Man-Vehicle System Research Facility, Building N257.

Multidisciplinary Research

W84-70046 **505-36-21**
Ames Research Center, Moffett Field, Calif.
AERONAUTICS GRADUATE RESEARCH PROGRAM
D. H. Hickey 415-965-5036
(505-36-11)

The objective of this program is to develop the interest of student engineers in the field of aeronautical engineering, provide on-the-job training in research methods, and augment or enhance NASA's research program. The approach is to bring the Center's needs to the attention of the academic community. Research topics

are established by mutual agreement to foster cooperative programs between the government and academia. Cooperation may be evidenced by use of each other's facilities and performance of the research at NASA installations. The Ames North research conducted under this RTOP will include aerodynamics, acoustics, flight mechanics, and computational fluid dynamics. It will be both theoretical and experimental in nature. The Ames/Dryden research supports work to improve methods and techniques in flight testing of aeronautical vehicles. The program is to promote the overall improvement in flight research through simultaneous advancement in instrumentation, testing methods, equipment, data recording, and data analysis. This RTOP in FY-84 combines the previous programs of Graduate Research and Post-Baccalaureate.

W84-70047 **505-36-22**
Lewis Research Center, Cleveland, Ohio.
GRADUATE PROGRAM IN AERONAUTICS
Marvin E. Goldstein 216-433-4000

The objective is to sponsor graduate research and training in aeronautics which is relevant and acceptable to both NASA and the University and to encourage a greater number of newly graduating, U.S. citizen engineers to pursue graduate training. A significant portion of that training will be through student research conducted at Lewis Research Center.

W84-70048 **505-36-23**
Langley Research Center, Hampton, Va.
GRADUATE PROGRAM IN AERONAUTICS
Robert H. Tolson 804-827-2664

The objective of this plan is to support university research in aeronautics in which there is substantial involvement of graduate students at the Langley Research Center. While formal classroom activities are conducted at a university campus, a substantial portion of the graduate research activity is carried out at the Langley Research Center in conjunction with Langley staff and under the overall guidance of a faculty advisor. The research pursued under this RTOP is aeronautics related. Research grants or cooperative agreements are awarded to a number of universities to pursue aeronautical research with support being mainly for graduate research students and to some extent faculty members associated with those students. The selection of graduate research topics is determined by joint agreement between the university and NASA staff.

W84-70049 **505-36-41**
Ames Research Center, Moffett Field, Calif.
JOINT INSTITUTE FOR AERONAUTICS AND AEROACOUSTICS (JIAA) INSTITUTE
Wallace Deckert 415-965-5486
(505-36-11; 505-36-21)

The objectives of this RTOP are to conduct basic and applied research in aeronautics and acoustics, to develop the interests and talent of student engineers in these fields, and to promote continued and intense involvement in joint research endeavors between Center scientists and those at the Institute. This will provide opportunities for mutual enhancement and augmentation of the graduate's research and education and NASA's research programs. The RTOP provides core funding for the Ames/Stanford Joint Institute for Aeronautics and Acoustics.

W84-70050 **505-36-42**
Lewis Research Center, Cleveland, Ohio.
JOINT INSTITUTE FOR AEROSPACE PROPULSION AND POWER
F. J. Montegani 216-294-6432

The Joint Institute of Aerospace Propulsion and Power (JIAPP) is a collaborative undertaking between Lewis Research and the University of Akron, Case Western Reserve University, Cleveland State University, the University of Toledo, and other academic institutions yet to affiliate. The Objective is to conduct scholarly research in the multiple disciplines underlying aerospace propulsion and power utilizing the preeminent resources of the collective institutions. The approach is to engage center engineers and scientists and university personnel, especially principal investigators, in collaborative research efforts of a personal, day-to-day nature at a working level with emphasis on utilization of center research facilities.

W84-70051 **505-36-43**
Langley Research Center, Hampton, Va.
JIAFS BASE SUPPORT
R. H. Tolson 804-827-2664
(505-36-23)

The objective of this plan is to provide a core level of funding for the Joint Institute for Advancement of Flight Science (JIAFS), which is an extension of the School of Engineering and Applied Science, George Washington University, located at the Langley Research Center. This core program allows the flexibility for developing new areas of research and through support for ongoing administrative personnel and provision for additional Graduate Research Scholar Assistantship appointments, will give JIAFS a degree of institutional stability and flexibility. The specific research topics in the program will be determined through mutual agreement between LaRC and GWU.

W84-70052 **505-36-50**
National Aeronautics and Space Administration, Washington, D.C.
CFD TRAINING PROGRAM
Randolph Graves, Jr. 202-755-3280

The objective of the program is to produce highly trained people with advanced degrees in computational fluid dynamics (CFD) by developing a balanced graduate training program in CFD at a few selected universities. A balanced program contains training in fluid physics, aerodynamics, computational methods, and computer science.

Computer Science and Applications Research and Technology

W84-70053 **505-37-01**
Ames Research Center, Moffett Field, Calif.
ADVANCED COMPUTATIONAL CONCEPTS AND CONCURRENT PROCESSING SYSTEM RESEARCH
J. O. Arnold 415-965-6209
(505-37-31; 506-51-11; 506-53-11; 505-31-01)

The objective of this research is to better support Computational Fluid Dynamics (CFD), Computational Chemistry and other disciplines of interest to the Agency by developing an understanding of the relationships and tradeoffs between algorithms and computer architectures for these applications. This will require the development of the necessary approaches, techniques, and tools to apply this fundamental insight to the development of optimal hardware/software systems for this class of problems. This will permit better utilization of the emerging concurrent processors and will influence the design of the cutting edge hardware/software systems crucial to NASA in the 1990's. The approach involves the collaboration of the Advanced Computational Concepts group, Computational Research and Technoloy Branch, and Ames' new Research Institute for Advanced Computer Science (RIACS). This collaboration will bring together computer science and computational physics expertise to analyze the requirements, evaluate extant concepts and products, and conduct the necessary research and development. The steps involved will include the development of: (1) requirements analysis and characterization techniques; (2) analysis, simulation, emulation, or modelling techniques to validate system concepts; and (3) promising systems concepts, and hardware/software prototypes to serve as proofs of concept. The research results are being reported in the appropriate literature, management briefings, workshops, seminars, and symposia.

W84-70054 **505-37-03**
Langley Research Center, Hampton, Va.
SOFTWARE TECHNOLOGY FOR AEROSPACE NETWORK COMPUTER SYSTEMS
E. C. Foudriat 804-865-2077
(505-37-13; 505-37-23; 505-37-83)

The basic objective of the program is to demonstrate cooperative autonomous systems technology by building, over the next four years, an experimental system. As space and aircraft systems become more complex, they will be distributed into semiautonomous subsystems and networked to form a total system. Hence, the concept cooperative autonomy. To demonstrate cooperative autonomy, components of the Software Development Lab and the Intelligent Systems Research Lab will be networked to a simulation of a spacecraft typical of that required for parts of a remote orbital servicing system (ROSS). This will show that special purpose subsystems can be integrated for simulation and that multipath networking will provide the additional reliability and flexibility for spacecraft. The basic objectives for implementing cooperative autonomous software can be subdivided into at least three critical technologies which will be investigated with this RTOP: languages, programming environments, and operating systems. Language structure research (RECOVERABLE OBJECT) related to recovery and roll back after failure has been started in FY 82. Control of recovery as studied by Randal, Kim, etc., and effective caching of recovery information are critical to real time, reliable operation. Future research is planned in the area of program verification to exploit the fact that path expressions have their foundation in the analysis of Petri nets and others have shown the relationship between path invariants and verification. Preliminary studies of network debugging and monitoring techniques are already underway at SUNY. These involve monitor and display of process status, execution history storage to 'replay' malfunctioning tasks, and user interaction with selected tasks. Synthesizing interfaces will involve incorporating concurrency and network concepts into both the operation and user features of ISIS by conversion from Pascal to Path Pascal. The research of the University of Illinois, SUNY, and others where applicable, will be incorporated into the in-house, specifically, the SUNY work on multipath networking and the studies on programming environment including critical test and debug. As components are prototyped using ISIS, they can be interfaced with the ROSS project for use, evaluation, and critique. This rapid feedback will be invaluable in correcting design and detecting implementation faults both in hardware and software. Experiments will seek node commonality, e.g., high level system protocol for data transmittal and signaling, which may be desirable to incorporate into firmware in later designs. In addition, the program will include in FY 84, at least one additional grant or contract directed toward distributed robotic system software requirements and design. The grant will be closely coordinated with other ROSS studies.

W84-70055 **505-37-10**
National Aeronautics and Space Administration, Washington, D.C.
AEROSPACE COMPUTER SCIENCE UNIVERSITY RESEARCH
Ronald L. Larsen 202-755-2395
(506-54-50)

The objective is to develop a university-based center for aerospace computing technology, focusing on concurrent processing, highly reliable computing, and scientific and engineering information management. Another task will be to foster cooperative, coordinated research coupling computer science with aeronautics, astronautics, and space sciences.

W84-70056 **505-37-13**
Langley Research Center, Hampton, Va.
RELIABLE SOFTWARE DEVELOPMENT TECHNOLOGY
Susan J. Voigt 804-865-2083
(505-37-03; 505-34-13)

As computers play an increasing role in complex aerospace systems, the requirement for reliable software intensifies. This research addresses methodologies for developing reliable software and techniques for assessing software reliability. Prototype tools and environments for both software developers and their managers are being developed, adapted, and studied to identify the most cost-effective approaches to develop reliable, quality software. A Unix-based workstation augmented with special management support tools and software development aids is currently the focus of this work. Experimental studies are underway to characterize software failures. A database of fault descriptions, failure conditions, and interfailure times will be built and subsequently used to analyze software reliability models and to explore quantitative relationships between quality metrics and the reliability of flight control programs. Fault-tolerant software design techniques and the feasibility of automatic software synthesis will be examined.

W84-70057 **505-37-17**
Lyndon B. Johnson Space Center, Houston, Tex.
HAL/S INTERACTIVE DEBUGGER SOFTWARE DEVELOPMENT/COMMON COMPILER
Josephine Jue 713-483-2504

The HAL/S Language Definition and User Coordination Group, also referred to as the NASA HAL/S Board, was established in 1977 to provide language control for the standard HAL/S compiler, tools, and documentation. Board activities for FY-84 include an interactive debugger, completion of the HAL/S front-end study, and partial standardization implementation resulting from the study.

W84-70058 **505-37-23**
Langley Research Center, Hampton, Va.
ENGINEERING DATA MANAGEMENT AND GRAPHICS
Susan J. Voigt 804-865-2083

Engineering and scientific data possess distinctive characteristics not suitably handled in commercially available data management systems and graphics systems. This research work is intended to identify and investigate alternative approaches for improving the functionality, performance, and human interface of engineering and scientific database management systems and to develop and demonstrate graphical software tools for engineering and scientific users. The functionality and suitability of a database processor for engineering data will be studied through experience with a prototype. Facilities for data definitions for numerical data structures will be developed, followed by a model for the performance evaluation of storage management schemes. Human interface specifications for DBMS users will be developed and the feasibility of transforming the user interface dynamically, based upon such information, will be investigated. High-level graphics extensions to a programming language will be defined, and a library of graphics tools for three dimensional realistic display will be developed, including reflectance, shadowing, and hidden surface.

W84-70059 **505-37-31**
Ames Research Center, Moffett Field, Calif.
COMPUTER APPLICATIONS
F. R. Bailey 415-965-6419

The overall objective of this effort is to provide operations support to the Numerical Aerodynamic Simulation (NAS) Program. This shall be composed of direct program support during the installation, test and integration, and development of the Numerical Aerodynamic Processing Network System (NAPNS), user support, and transition from interim to full operations. Support will provided in conjunction with the development phases of the NAS Program; Phase 1 - Network Prototype Development, Phase 2 - Initial Operating Configuration Development, and Phase 3 - Extended Operating Configuration Development.

W84-70060 **505-37-33**
Langley Research Center, Hampton, Va.
COMPUTER-AIDED DESIGN
R. C. Goetz 804-865-2042

The objective of the research is to exploit technical advances in computers to aid the engineering design and analysis process. The scope of the effort includes development of techniques of data base management for large-scale engineering design activities as well as the use of special purpose computer hardware and software to facilitate structural computations. In FY-1984, the

CAD/CAM Engineering Information Management project will continue research on large-scale design data base management. Efforts will be focused on the development of a distributed data base management design that interfaces with commercial systems. Ongoing work will continue on the development of a Finite Element Machine (FEM), an array of microprocesses especially configured to solve structural analysis problems. In FY-1984, results will be obtained from structural applications on an 8-node FEM configuration.

W84-70061 **505-37-41**
Ames Research Center, Moffett Field, Calif.
CLASS VI COMPUTATIONAL CAPABILITY SUPPORT
David L. Fisher 415-965-5015

The objective of this RTOP is to provide the research community at AMES with state-of-the-art computational tools which will enable the researchers, particularly in the computational physics community, to maintain their preeminence. This capability includes hardware and software, as well as the staff required for operations, maintenance and planning to provide the enhancements needed to ensure that the computational capabilities remain at the state-of-art.

W84-70062 **505-37-42**
Lewis Research Center, Cleveland, Ohio.
COMPUTATIONAL FACILITIES
Ralph K. Everett 216-433-6163

This RTOP covers the cost for lease, purchase, and maintenance of the hardware and system software for the High Speed Analytical Processor (Cray IS computer system). The system is installed in the central computer facility with the existing IBM 370/3033 attached processor providing the input and output for the system. The system is used primarily for scientific computation (math modeling) with emphasis on analysis of aerodynamics, thermal and structural performance characteristics of propulsion system components.

Propulsion Systems Research and Technology

W84-70063 **505-40-02**
Lewis Research Center, Cleveland, Ohio.
INLETS AND NOZZLES
B. A. Miller 216-433-4000
(505-31-02; 505-43-82; 505-43-42)

A comprehensive flow prediction methodology for the design of inlets and nozzles will be generated to achieve high performance with increased propulsion system stability. Computer analysis programs for predicting internal and external flows will be synthesized in-house and by contracts and grants under RTOP 505-31-02. These programs will make it possible to analyze viscous and inviscid flows in two and three dimensions. In this RTOP basic benchmark testing will define detailed flow phenomena to guide and verify the analysis, and verification experiments will be conducted to verify the accuracy of computer codes for design of actual components. Inlet and nozzle hardware will be designed and used to conduct exploratory research in areas that are not presently amenable to analysis.

W84-70064 **505-40-12**
Lewis Research Center, Cleveland, Ohio.
FAN AND COMPRESSOR RESEARCH
L. D. Nichols 216-433-6906
(535-05-12; 505-31-52)

The objectives of this RTOP are to improve efficiency, operating range, distortion tolerance, durability and reliability, and to reduce the weight, volume and cost of fans and compressors. Increased emphasis is placed on fundamental high speed experiments to understand the internal flow physics and to verify the internal flow analysis codes to improve the accuracy and reliability of the compressor design system. The advanced internal flow analysis methods will result in improved designs and large cost savings by reducing the time required to incorporate advanced compressor technology into future engine development programs. Research is also directed towards developing a fundamental understanding of compressor stalling phenomena and how it is influenced by compressor design parameters. Models for predicting stalling characteristics and recovery of advanced compression systems are being developed and high speed verification experiments are planned. Advanced instrumentation and measurement systems will be developed and applied for use in component research, engine systems research, and eventually in operational systems. Research is focused on developing a technology base for producing high temperature transducers and electronic systems that can operate uncooled on or in close proximity to a turbine engine for the purposes of control, condition monitoring or experimentation. State of the art prototype instrumentation will be developed with emphasis in the applications of microcomputers and minicomputers for the automation of instrumentation with respect to operation, calibration, and pre-run checkout.

W84-70065 **505-40-22**
Lewis Research Center, Cleveland, Ohio.
COMBUSTORS AND TURBINES
R. A. Rudey 216-433-6625
(505-31-42; 533-04-12)

The objective of this RTOP is the improvement of performance, life, and reliability of combustors and turbines for civil and military applications. Combustor research will include analytical model development and verification as well as the identification and evaluation of advanced combustor and fuel system concepts. The effects of fuel property variations on the performance, reliability, and durability of fuel system components will be investigated and advanced fuel system concepts will be identified and evaluated that enable the use of broader property fuels. Turbine research will involve improved cooling and aerodynamic design methods for axial turbines. This work, in conjunction with related programs in fundamental analysis and experiments and hot section technology, result in large cost savings by reducing the time required and the risk involved in incorporating advanced components into future engine development programs.

W84-70066 **505-40-32**
Lewis Research Center, Cleveland, Ohio.
PROPELLER RESEARCH
Daniel C. Mikkelson 216-433-6820
(535-03-12)

The objective of the Propeller Research Program is to advance the technologies that are critical to efficient, acceptable propeller propulsion both at high subsonic speeds (Mach 0.7 to 0.8) and at lower speeds typical of business and small short haul aircraft. This objective will be accomplished by developing advanced analysis methods that accurately predict propeller aeroelastic characteristics, and that better model propeller acoustics and structural behavior. Advanced and unique propeller concepts will be evaluated that enhance propeller performance, improve structural stability, lower noise, and reduce weight. Also, new techniques will be established for the design and fabrication of advanced composite propeller structural concepts with improved operating characteristics for business and commuter aircraft.

W84-70067 **505-40-42**
Lewis Research Center, Cleveland, Ohio.
POWER TRANSFER RESEARCH
D. J. Gauntner 216-433-4000

The objectives of this RTOP are to advance the state-of-the-art in the technology of transmissions and of mechanical components such as bearings and gears. Goals are to achieve improved component performance, life, noise, weight, reliability and efficiency in the high temperature and high speed environments of turbojet and turbofan engines and mechanical power transmission systems for helicopters, V/STOL and turboprop applications. Emphasis will be given to analytical performance predictions with experimental verification to create far term opportunities as well as to satisfy

goals for both improved component and system performance. Experimental studies will be performed with standard type transmissions with improved bearing and gear components and with advanced hybrid and traction transmissions using traction contacts. Materials, lubricants, and design variables will be studied for improved component and system reliability and life.

W84-70068 **505-40-52**
Lewis Research Center, Cleveland, Ohio.
ENGINE DYNAMICS AND CONTROLS
R. Willoh 216-433-6624

The objective of this RTOP is to provide improved understanding of propulsion system dynamic behavior and to establish dynamic performance and stability prediction techniques for future engine system and engine control development. Analytical and experimental research programs are undertaken to support the various technical disciplines associated with the dynamic behavior and control of engine systems. The approach in the system dynamics areas is to conduct analytical and experimental research subprograms on advanced civil and military engines. Particular emphasis is placed on the dynamic interaction problems encountered when individual components are combined to form an engine system. Subprograms include investigations into the stall stagnation phenomenon, engine system stability and the effects of various disturbances on system dynamic behavior. Research will also be conducted on the dynamic effects of new components and system configurations. Real-time dynamic simulations of propulsion systems are developed using hybrid computer. Research into the use of parallel microprocessors for real-time simulation is also conducted. Innovative propulsion control components are developed, with emphasis on electro-optical sensors and actuators. Analytical and experimental research is conducted on post-stall engine system dynamic behavior. Control modes for avoidance of and recovery from rotating stall are synthesized and evaluated using simulations and engines.

W84-70069 **505-40-62**
Lewis Research Center, Cleveland, Ohio.
INTERMITTENT COMBUSTION ENGINE RESEARCH
Edward A. Willis 216-433-6909

To define and establish the technology base for the most promising advanced small engines for future light civil airplanes, commuter, rotorcraft and light military aircraft for the late 1980's and on. Advanced engines having multifuel capability, substantially lower BSFC, weight, maintenance and improved reliability are being defined through studies and engine tests, supplemented by analyses and experimental investigations in key technology areas.

W84-70070 **505-40-70**
Lewis Research Center, Cleveland, Ohio.
ENGINE SYSTEMS FACILITIES OPERATIONS
A. J. Gnecco 216-433-5579

This RTOP covers the operation, maintenance, repair, and improvements of the Propulsion System Laboratory (PSL) and the engine static test stands (ECRL-2) and Vertical Lift Fan Facility (VLFF) at LeRC. The PSL complex consists of two altitude test chambers, designated as PSL-3 and PSL-4. ECRL-2 is an indoor static stand and VLFF is an outdoor static stand. The objective is to provide safe and productive operations of the engine test facilities for propulsion and aerodynamic systems research and technology directed towards improving systems technology for future turbofan, turbojet and turboshaft engines. This will be accomplished through the application of research sub-programs to advanced civil and military engines. This RTOP covers the cost of operating PSL, ECRL-2 and VLFF in support of the above research plus the cost of maintaining, repairing and assuring the safety of these major facilities. Funding for improving the facilities' capabilities, maximizing the productivity, and improving energy efficiency are also included.

W84-70071 **505-40-72**
Lewis Research Center, Cleveland, Ohio.
WIND TUNNEL OPERATIONS
A. J. Gnecco 216-433-5579

This RTOP covers the cost of maintenance, normal repair and limited improvements of all the wind tunnel facilities at LeRC. These facilities consist of the 10x10-foot supersonic wind tunnel, 8x6-foot Supersonic Wind Tunnel, 9x15-foot Low Speed Wind Tunnel, and the 6x9-foot icing research tunnel. The cost of operating the wind tunnels during research testing and to prepare the tunnel for specific research tests are not covered under this RTOP.

W84-70072 **505-40-82**
Lewis Research Center, Cleveland, Ohio.
PROPULSION STUDIES
L. H. Fishbach 216-433-6167

To perform studies of the feasibility and potential benefits of advanced propulsion concepts, to identify technology research requirements and define opportunities for capitalizing on technology advances. Studies will be performed of engine cycles, propulsion systems and engine/airframe combinations in aircraft missions.

Rotorcraft Research and Technology

W84-70073 **505-42-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT AEROMECHANICS AND PERFORMANCE RESEARCH AND TECHNOLOGY
W. Johnson 415-965-5043
(532-03-11; 532-06-11)

This RTOP covers research on rotor aerodynamics, dynamic loads and stability, performance and noise characteristics; rotorcraft flight dynamics and rotorcraft human factors. Theoretical and experimental research will be conducted to improve fundamental understanding and develop techniques to design rotors optimized for aerodynamic performance and noise reduction. These techniques will include the effects of planform geometry, airfoil section, and dynamic stall. The understanding and predictive capability of the aerodynamic and dynamic phenomena of advanced rotorcraft will be improved by conducting analytical, small scale, and full scale experimental investigations of helicopter performance and noise; rotor aerodynamics and wake characteristics, drag and aerodynamic interference; and rotor loads, vibration, and vibration reduction systems. Flight dynamics research will be conducted to provide handling qualities and design criteria for specific missions. The research will be conducted through analysis, including math model improvement and development of advanced techniques of control system implementation; ground based piloted simulation; and flight research. Human factors research will concentrate on fundamental laboratory studies to reveal the needs and information processing of helicopter pilots.

W84-70074 **505-42-23**
Langley Research Center, Hampton, Va.
ROTORCRAFT AIRFRAME SYSTEMS
Robert C. Goetz 804-865-2042
(532-06-13)

The objectives of this research are: to develop the technology for the application of composite materials and design concepts in helicopter structures and to improve performance and efficiency, reduce costs, and provide equivalent durability and energy absorption capability compared to metal structures; to determine by analytical and experimental study effective means for reducing helicopter vibrations and to determine and evaluate the aeroelastic characteristics of new rotor concepts; to develop an experimental data base and improved analytically and empirically-based prediction methods for determining rotor blade unsteady aerodynamic loads; to gain a fundamental understanding of the dynamics of blade/vortex interaction and other leading components of helicopter rotor noise with an aerodynamic origin; and to acquire

experimental aerodynamics and acoustics data for helicopter systems and components for correlation with analysis.

W84-70075 **505-42-32**
Lewis Research Center, Cleveland, Ohio.
ROTORCRAFT OPERATING PROBLEMS
N. E. Samanich 216-433-5175

Part of the NASA Rotorcraft Program is focused on advancing critical technology needed to solve propulsion, power transfer, and icing problems associated with operation of military and civil rotorcraft. Objective of this research is to improve propulsion system durability, reliability, and cruise fuel consumption, to reduce life cycle costs, and to develop technology aimed at improving productivity, operational capability, ride quality, and passenger comfort. Recent and planned activities include systematic analytical evaluations of various contingency power concepts with some verification testing; a conceptual design and feasibility study of torque converters for high-speed rotorcraft propulsion systems; research directed at reducing internal cabin noise and vibration by development of low-noise gearbox design methodology; and the continuation of rotorcraft icing research aimed primarily at establishing and verifying analytical/empirical techniques for use in ice prediction and ice protection systems.

W84-70076 **505-42-61**
Ames Research Center, Moffett Field, Calif.
FLIGHT TEST OPERATIONS
F. J. Drinkwater 415-965-5687
(532-03-11; 532-09-11; 533-02-50)

The objective of this effort is to provide overall operations support for Ames research aircraft flight experiments in low speed aerodynamics, flight dynamics and control, guidance and navigation and avionics systems. This support activity consists of aircraft operations and maintenance required to carry out the flight tests, and the operation of ground based facilities which provide data acquisition and processing, aircraft tracking, landing guidance, communications, noise and meteorological measurements, and aircraft instrumentation.

W84-70077 **505-42-71**
Ames Research Center, Moffett Field, Calif.
OPERATION OF FLIGHT SIMULATION FACILITIES
Anthony M. Cook 415-965-5162

This RTOP covers the support and operation of the Flight Simulation Facilities at Ames Research Center. These facilities consist of the Vertical Motion Simulator (VMS), the Flight Simulator for Advanced Aircraft (FSAA), the Interchangeable Cab (ICAB) Development Station, and a Flight and Guidance Laboratory containing multiple simulation facilities and computer labs. The objective of this RTOP is to provide flight simulation support in research and technology programs for NASA, DOD, FAA, industry and other Government agencies in the areas of handling qualities, flight dynamics, control systems development, guidance and navigation, pilot/systems interface, cockpit displays, and simulation technology. Flight simulation experiments will be related to various types of aircraft and rotorcraft as well as Space Shuttle vehicles.

W84-70078 **505-42-81**
Ames Research Center, Moffett Field, Calif.
LOW-SPEED WIND TUNNEL OPERATIONS
J. V. Kirk 415-965-5045

This RTOP covers support and operation of the National Full-Scale Facilities Complex at Ames Research Center (40 by 80 Foot Wind Tunnel, 80 by 120 Foot Wind Tunnel, and Outdoor Aerodynamic Research Facility) and the 7 by 10 Foot Wind Tunnel. The objective of this RTOP is to support research on basic fluid mechanics, rotorcraft aeromechanics and acoustics, V/STOL aerodynamics, and the high lift aerodynamics of conventional aircraft. The 40 by 80 and 80 by 120 Foot Wind Tunnels will not be operable until the second quarter of 1985. In the interim, the 40 and 80 Foot Test Section is being used to conduct static testing on models and aircraft to obtain data that will reduce the amount of wind-on time when the tunnels are back in operation.

High-Performance Aircraft Research and Technology

W84-70079 **505-43-01**
Ames Research Center, Moffett Field, Calif.
POWERED LIFT RESEARCH AND TECHNOLOGY
Bedford A. Lampkin 415-965-6039

The objective of this RTOP is to develop basic research and technology required to enable the development of military and civil aircraft having STOVL, V/STOL, and STOL capability and viable mission performance. Theoretical and experimental generic and configuration specific research will be undertaken in the areas of high-speed aerodynamics, low-speed aerodynamics, and flight dynamics. To ensure that all major high-speed propulsion system/airframe interactions are accounted for properly, compact propulsion simulator technology will be developed and used in scale wind tunnel models of powered lift configurations. Methods for predicting high-speed aerodynamic performance will be refined. Low-speed wind tunnel aerodynamic research will continue to develop aerodynamic prediction techniques for both transition and ground effects. Experimental database will be expanded using large-scale components and complete models. Research will also include improvement of experimental techniques. An Ejector Augmented Lift Technology Program jointly funded by the Canadian government and the Navy will conduct generic and configuraton specific research to investigate advanced ejector concepts and aircraft installed flight type ejector system performance. Flight control system and display requirements will be investigated concurrently, primarily through piloted simulation and through flight research in collaboration with the Royal Aircraft Establishment of the U.K.

W84-70080 **505-43-02**
Lewis Research Center, Cleveland, Ohio.
POWERED LIFT PROPULSION TECHNOLOGY
L. W. Gertsma 216-433-6668

An efficient, lightweight, reliable propulsion system is a critical requirement for the successful design of powered lift aircraft. The technology base for the propulsion system will be developed in selected critical areas which are unique to the powered lift concept. Analytical and experimental investigations will be conducted in the areas of inlets, thrust deflector nozzles, thrust augmentation systems, and thrust control devices operating in the hover and transition modes for both subsonic and supersonic propulsion system concepts.

W84-70081 **505-43-03**
Langley Research Center, Hampton, Va.
V/STOL FIGHTER TECHNOLOGY
R. E. Bower 804-827-3285

The broad objectives are to provide fundamental aerodynamics, stability and control, and flight dynamic information on advanced fighter concepts designed for short or vertical takeoff and landings. The work will be conducted with recognition of and in support of the Ames lead-Center role in V/STOL technology. The research will include work on advanced thrust vectoring and reversing concepts proposed for STOL/STOVL demonstrator aircraft, powered-lift arrangements such as spanwise blowing, over-the-wing or externally-blown jet flaps, ejectors, and lift engines and lift-fan concepts. Specific objectives are: (1) to investigate low-speed performance, stability and control in and out of ground effect of advanced STOL/STOVL fighter concepts-with the initial effort concentrated on the NASA/GD STOVL demonstrator design, (2) to investigate low-speed handing qualities, stall/spin characteristics, and control-system requirements for safe and effective STOL/STOVL operation, and (3) to define and develop airframe/propulsion control concepts (aerodynamic, thrust vectoring, reaction jet, etc.) and control-law techniques to meet operational requirements. The method of approach for these efforts is to use the unique facilities available at Langley which include the moving ground belt test technique in the 4- by 7-meter tunnel and the free-flight test technique in the 30- by 60-foot tunnel. In addition,

supporting work will include static- and dynamic-force tests, spin-tunnel tests, and piloted simulator studies in the Langley differential maneuvering simulator.

W84-70082 **505-43-11**
Ames Research Center, Moffett Field, Calif.
HIGH-ALPHA AERODYNAMICS AND FLIGHT DYNAMICS
G. N. Malcolm 415-965-5066

The objective is to provide a basic understanding of the aerodynamics and flight dynamics of high performance aircraft and highly maneuverable fighter aircraft. Major efforts are directed towards: (1) providing improved wind tunnel and flight test techniques and hardware and analytical methods for predicting the flight behavior of such vehicles in all phases of flight from controlled maneuvers to fully developed spins; (2) providing better understanding of the fundamental fluid dynamics phenomena incuding 3-D separated flows, vortex flows and massive stalled wakes; and (3) improving analytical techniques for determining stability and control derivatives from flight data and to develop new techniques for evaluating handling qualities. Emphasis in the ground-based tests is in the high-angle-of-attack, high-Reynolds-number regime, and addresses both static and dynamic characteristics. A coordinated program of wind tunnel and flight tests is planned to provide means for wind tunnel/flight correlation. Both generic configurations and actual flight a/c configurations will be utilized (F-15, F-18).

W84-70083 **505-43-13**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS AND CONTROLS
J. W. Stickle 804-865-2037

The broad objectives of this RTOP are to improve the stall/spin characteristics of high performance aircraft; and to determine and evaluate the architecture of integrated digital airframe/propulsion control systems for such vehicles. Specific objectives of the stall/spin research are: (1) to investigate the fundamental nature of stall/spin including the development of test techniques and theoretical methods; (2) to develop and evaluate automatic spin prevention concepts; (3) to determine static and dynamic aerodynamic characteristics at high angle of attack; and (4) to determine geometric characteristics which result in inherent spin resistance. Methods of approach for these efforts include static and dynamic wind tunnel force tests, theoretical analysis, piloted simulator tests, and dynamic model flight tests. Extensive participation in DOD airplane programs is involved. Specific objectives of the integrated controls research are: (1) to assess the benefits/disadvantages of system architectures with airframe/propulsion control coupling; (2) to identify key hardware elements requiring development to insure availability for advanced applications; (3) to design, build and evaluate the selected system; and (4) to assess the need for flight test demonstration. The system evaluation research will be conducted in the Langley Avionics Research Laboratory (AIRLAB). The controls program is directed by the Langley Research Center with technical assistance by the Lewis Research Center.

W84-70084 **505-43-23**
Langley Research Center, Hampton, Va.
HIGH-SPEED AERODYNAMICS AND PROPULSION INTEGRATION
Roy V. Harris, Jr. 804-865-2658

The technical objective of this work is to develop the aerodynamic technology base for the design of future military aircraft and missile concepts. Analytical and experimental studies will be made to develop aircraft design rationale and evaluate advanced aerodynamic concepts, such as, supercritical aerodynamics, wing warp, maneuver devices, thrust-induced lift, nonaxisymmetric nozzles, and component interference. Similar studies will be made to extend the aerodynamic technology base for missile systems includng conventional cruciform stability and control concepts, airbreathing propulsion integration, and monoplanar concepts. Studies will also be made to provide a technology base for evaluation of missile carriage and separation aerodynamics.

W84-70085 **505-43-31**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
INTERAGENCY ASSISTANCE AND TESTING
R. G. Bryant 805-258-3311

This RTOP is intended to cover interagency and intercenter assistance using applicable Ames-Dryden flight test facilities. The broad objective is to provide technical assistance, consultative services and test facility support to DoD for military programs and to industry and other NASA Centers, which involve specific requests for NASA support. Past activities of this kind include a B-52 drop test for recertification of the F-111 crew escape system; component improvement tests involving F-15, T-37, F-111 aircraft and support of the AFTI/F-16 program. Current activities include planning for and conduct of Marshall Space Flight Center solid rocket booster recovery system drop tests, and support of Joint Navy F-14 Flight Test Program. Analysis to test results will be performed and selected results will be documented. Consultation will include participation in pre-test conferences, technical evaluation boards, and technical coordination committees.

W84-70086 **505-43-32**
Lewis Research Center, Cleveland, Ohio.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
A. J. Gnecco 216-433-5579

The objective of this RTOP is to support requests from DOD, FAA other Federal agencies outside NASA and the aircraft/missile industry for aerodynamic testing in facilities at the Lewis Research Center. The facilities typically used under this RTOP include: 10x10 SWT, 8x6 SWT, 9x15 LSWT, Icing Tunnel and PSL. Additional support is also provided in the form of technical assistance, consultative services and participation in the technical evaluation of developing aircraft and missile concepts.

W84-70087 **505-43-33**
Langley Research Center, Hampton, Va.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
R. V. Harris, Jr. 804-865-2658

The broad objective is to provide technical assistance and consultative services to outside agencies and aircraft industry programs which involve specific requests for NASA support. The principal assistance is to the Department of Defense for aircraft and missile development programs. Currently, activity is focused in the areas of stall/spin; aerodynamic characteristics at subonic, transonic, and supersonic speeds; flutter and aeroelasticity; structures; landing loads; simulation; and propulsion system interactions on airframes and nozzles. The approach will involve tests in applicable Langley facilities consistent with the availability of test time and the utilization need for the particular facilities requested. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pretest conferences, technical evaluation boards, and technical coordination and oversight committees.

W84-70088 **505-43-42**
Lewis Research Center, Cleveland, Ohio.
SUPERSONIC PROPULSION INTEGRATION TECHNOLOGY
B. A. Miller 216-433-4000
(505-40-02; 505-43-82; 505-31-02)

A technology data base for high-speed military and civil aircraft design concepts incorporating improved propulsion system/airframe integration techniques will be generated. Present high speed inlet/engine/nozzle/airframe integration concepts and methods will be evaluated and the generation of advanced concepts and methods will be initiated. Inlet aerodynamic, stability and control analysis/design methods will be assembled and evaluated. Existing inlet or nozzle hardware will be modified or new hardware will be built and tested to verify aerodynamic and control analysis methods and to provide a data base for areas such as low speed aeroacoustics.

W84-70089 **505-43-43**
Langley Research Center, Hampton, Va.
SUPERSONIC AERODYNAMICS, CONFIGURATIONS, INTEGRATION, STRUCTURES AND MATERIALS TECHNOLOGY
D. J. Maglieri 804-865-3838
(534-02-23)

The objective of this RTOP is to develop a technology data base for high-speed military and civil aircraft design concepts of advanced configurations incorporating improved aerodynamic performance, propulsion system/airframe integration techniques, and structures and materials. This will be accomplished primarily through in-house studies and experimentation to: (1) establish a supersonic aerodynamic technology base that permits improvements in L/D, reduction in drag, refinement of aircraft concepts, and optimization of aircraft characteristics over the full operating speed range; (2) evolve and refine advanced military and civil aircraft configurations that provide advancements in performance, range, speed, volume, boom signature, fuel consumption, etc.; and (3) establish a high-temperature structures and materials technology base that permits significant reductions in structural weight by research on new materials, structural design, and fabrication techniques providing satisfactory fatigue, fracture, and thermal/cylic life characteristics under high-speed flight conditions.

W84-70090 **505-43-53**
Langley Research Center, Hampton, Va.
HIGH ALTITUDE AIRCRAFT TECHNOLOGY
J. W. Youngblood 804-865-3666

This RTOP will focus attention on enabling technologies and design concepts for unmanned, high-altitude, long-endurance airplanes. Emphasis will be placed on identifying technology areas which are marginal but hold promise of being enhanced in the foreseeable future; e.g., solar, nuclear, and beamed microwave propulsion systems, low Re aerodynamics, and ultralight structures. The development of analytical and conceptual design tools applicable to this class of aircraft will continue. Mission/payload scenarios will be developed to drive conceptual designs and identify technology requirements in areas of materials, structures, airfoil, propellers, configuration aerodynamics, and propulsion systems; environmental constraints; and mission/flight control techniques. Liaison will be maintained with potential users and commercial interest for this class of aircraft. A plan for long-range development of critical technologies and demonstration of critical subsystems will also be developed.

W84-70091 **505-43-60**
Ames Research Center, Moffett Field, Calif.
DATA ANALYSIS FACILITY UPGRADE
D. C. Bacon, Jr. 805-258-3311

The objective is to maintain technical preeminence through the modernization of experimental facilities. The Flight Loads Research Facility was constructed in FY-64; the temperature/load control systems were last updated in FY-70. A large program has been proposed which will test simultaneous heating and loading of OV101. This test program will provide knowledge about the reactions of the orbiter under thermal/mechanical loads, and provide assistance in interpreting OV101 flight loads data. The present systems are outdated, difficult to maintain, and becoming increasingly unreliable. The processor at Dryden was installed in 1972. The interim processor is now scheduled for an average 130 hours out of the possible 168 hours in a week. The central processor is currently being replaced using FY-83 and FY-84 funds. It is anticipated that funding for the projects in FY-85 and beyond will be included in the expanded Ames Facility Operating Plan.

W84-70092 **505-43-61**
Ames Research Center, Moffett Field, Calif.
HIGH-SPEED WIND TUNNEL OPERATIONS
Daniel P. Bencze 415-965-5848

This RTOP covers the operation, maintenance, repair and enhancement of the high speed wind tunnels at ARC. These facilities consist of the unitary plan wind tunnels (11 foot transonic, 9 by 7 foot and 8 by 7 foot supersonic), 12 foot pressure wind tunnel, 2 by 2 foot and 14 foot transonic wind tunnels, and the 6 by 6 foot supersonic wind tunnel. In addition, a number of smaller scale aerodynamic research and test facilities are maintained and supported as required. The objective of the RTOP is to provide aerodynamic testing in support of research and technology programs for NASA, DOD, industry, and other government agencies. Wind tunnel tests will be conducted to generate experimental test data to advance the state-of-the-art in generic research and vehicle configuration research. This RTOP also provides for limited facility modernization at Dryden Flight Research Facility.

W84-70093 **505-43-71**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FLIGHT SUPPORT
L. C. Barnett 805-258-3357

The objectives are to: (1) maintain and operate aircraft in support of the flight research and test programs conducted at the Dryden Flight Research Facility; (2) provide equipment, maintenance and operation for support aircraft including F-104, T-38, C-47 and Bell Helicopter and for service aircraft including B-52, PA30, and JetStar; (3) provide flight support for OAST programs including high performance flight research programs which are joint/cooperative with the Research and Space Flight Centers and joint/cooperative with agencies of the DOD; (4) provide aircraft for pilot proficiency to chase research aircraft as part of safety and productivity, as well as airborne platforms for multiple research program support; and (5) retire the C-47 during FY-84 from the active flight program. (A logistics/program support aircraft, provided through a lease with option to purchase plan in FY-84 and FY-85, will perform the support requirements).

W84-70094 **505-43-81**
Ames Research Center, Moffett Field, Calif.
HYPERSONIC AERONAUTICS TECHNOLOGY
B. M. Kock 805-258-3311

The Hypersonic Vehicle program is conducting research addressing the technology needs of long range cruise airplanes designed to operate at Mach numbers in excess of 3.0. The YF-12 research program provided an engineering data base that is supportive of the Hypersonic program. The focus of this RTOP is to apply that data base, as well as the experienced engineering personnel, to the aerodynamics, propulsion, structures and airplane operational disciplines for hypersonic vehicles. Analysis and laboratory testing will be provided.

W84-70095 **505-43-82**
Lewis Research Center, Cleveland, Ohio.
HYPERSONIC PROPULSION INTEGRATION TECHNOLOGY
B. A. Miller 216-433-4000

A program of applied research will be conducted to develop key propulsion and propulsion airframe integration technologies for application to air-breathing aircraft in the Mach 3-5 flight regime. A data base of performance and operational characteristics for advanced supersonic/hypersonic propulsion (inlet/engine(s)/airframe) concepts will be generated. Current inlet analytical prediction methods will be evaluated using this new data base. Key propulsion barrier technologies will be identified for further investigations. These studies will be conducted inhouse and on contract and is a joint LaRC/LeRC program.

W84-70096 **505-43-83**
Langley Research Center, Hampton, Va.
HIGH SPEED (SUPER/HYPERSONIC) TECHNOLOGY
R. V. Harris, Jr. 804-865-2658

The program is aimed at fundamental aerodynamic, propulsion, and structures technologies to support future development of airbreathing aircraft and missiles in the Mach 3-7 class. NASA in-house research capabilities and facilities will be utilized, supplemented by selected contracts and grants, to develop and combine critical methodologies. The aerodynamics effort will concentrate on propulsion/airframe integration aspects of hyper-

sonic configurations, including the forward aircraft flow field, spillage effects, and exhaust nozzles for multicycle turboramjet engines. Scramjet propulsion research will consist of combustion fundamentals for hydrogen and hydrocarbon fuels to include analytical techniques and flow field diagnostics, and of component and engine testing to investigate feasibility for the Langley airframe-integrated modular scramjet concepts. The structures focus will be on scramjet fuel injector strut design and fabrication, and on light-weight, long-life structural concepts applicable for methane-fueled ramjet engines. The approach will combine the development and application of advanced analytical methods with representative experiments. A parametric range of geometric shapes will be addressed to identify the best fundamental approaches to high vehicle, engine, and structures performance. Detailed flow field analyses will include parabolic and elliptic 3-D techniques, embedded shocks, inlet spillage effects, shock-boundary layer interactions, fuel injection, mixing and combustion.

Subsonic Aircraft Research and Technology

W84-70097 **505-45-11**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
OPERATIONAL PROBLEMS, FIREWORTHINESS AND CRASHWORTHINESS
K. E. Hodge 805-258-3311
(505-33-31)

One objective of this RTOP is to improve aviation safety by enhancing our knowledge of atmospheric processes, by increasing the understanding of the causes of accidents, and by developing systems technology and piloting techniques for avoiding hazards. An instrumented B-57B aircraft will gather data to characterize atmospheric anomalies such as wind shear, turbulence, and microbursts at altitudes up to 1000 meters. Research on post-accident analysis techniques is a cooperative program with the National Transportation Safety Board (NTSB). Research will also be conducted in new technology to reduce the hazards associated with wind shear and to enhance the operational safety of IFR operations for civil and military aircraft. A second objective of this RTOP is to improve aircraft crashworthiness and cabin safety in post-crash fires. The program includes: (1) development of cost-beneficial survivability model for aircraft fire safety; (2) development of fire-resistant fuselage insulation; (3) development of fire-retardant and crashworthy composites for interior applications such as aircraft seats; (4) development of lightweight graphite composites for fire-resistant aircraft interiors; (5) development of fire test methodology such as measurement of the mass injection rate of materials into the environment; (6) fabrication of advanced aircraft interior materials for testing by the FAA; and (7) full-scale demonstration of the technologies for improved survivability.

W84-70098 **505-45-12**
Lewis Research Center, Cleveland, Ohio.
AVIATION SAFETY: AIRCRAFT ICING AND FUEL EFFICIENCY RESEARCH
John J. Reinmann 216-433-5542
(505-42-32; 505-36-12; 505-36-42)

The objectives of this RTOP program are: (1) to advance the technology related to the safe and efficient operation of aircraft in atmospheric icing conditions, and (2) to develop interactive man-computer techniques to provide rapid and accurate meteorology information for use in fuel efficient flight planning. The icing program addresses the ice protection needs of general aviation, light transports, commercial transports, and helicopters. The program is broadbased, encompassing both analytical and experimental research. Icing R&D testing will be conducted in the NASA Lewis Icing Research Tunnel, and in flight tests in natural icing clouds and behind icing cloud simulators. The research will be coordinated among the aircraft industry/users, civilian government agencies, and the military. NASA will serve as the focal point for assembling and disseminating a wide range of data. The fuel-savings program involves the developments of a data base for high-resolution windfields and temperatures at cruise altitudes. The data base consists of automated pilot reports, radiosonde, numerical weather-prediction model and satellite data and will be optimized through interactive computer techniques applied to analysis and forecast fields. The program will involve a real-time test and evaluation.

W84-70099 **505-45-13**
Langley Research Center, Hampton, Va.
AVIATION SAFETY: SEVERE STORMS
J. W. Stickle 804-865-2037

The objective is to improve the knowledge of severe storm atmosheric processes as they affect the design and safe and efficient operation of aircraft and aircraft systems. Existing experimental programs will be continued to provide additional data for improving the detection and avoidance of severe storm hazards, and for the development of design and operating criteria for those hazards which cannot be avoided. Specific hazards include precipitation, wind shear, turbulence, and in-flight lightning. The lightning program is part of the joint NASA/FAA/DOD Atmospheric Electricity Hazards Program, and involves support fron NASA and DOD.

W84-70100 **505-45-15**
Jet Propulsion Laboratory, Pasadena, Calif.
AVIATION SAFETY TECHNOLOGY - APPLIED FLUID MECHANICS
Lloyd Back 213-354-3537

The overall objective of this effort is directed toward improving aircraft fire safety. The studies include those aspects of safety associated with: (1) Experimental investigations to study the ignition and flame spread characteristics of aircraft ceiling panels, and the interaction between a pool fire and ventilation crossflow in a one-third scale aircraft cabin simulation; and to evaluate and guide the development of a detailed enclosure fire dynamics model, utilizing the JPL Pool Fire and Flame Spread Test Facility. (2) The development of a detailed fire modeling methodology for the prediction of aircraft fire characteristics; and (3) Thermochemical modeling of burning materials.

W84-70101 **505-45-17**
Lyndon B. Johnson Space Center, Houston, Tex.
AIRCRAFT FIRE AND SAFETY TESTING
D. E. Supkis 713-483-4565

This RTOP consists of work originally started in 1975 and continued through FY-83. The RTOP provides for developing and testing new, lightweight, fire-retardant, nonmetallic materials, developing secondary aircraft structures and the fabrication of modules for in-house testing, testing by the aircraft industry and by associated agencies.

W84-70102 **505-45-19**
Marshall Space Flight Center, Huntsville, Ala.
ATMOSPHERIC PROCESSES FOR AVIATION SAFETY
D. W. Camp 205-453-2087

The objectives are to define, investigate and model atmospheric conditions having adverse effects on aircraft operations relative to efficiency and safety; conduct research relative to the development of techniques and procedures for enhancing safe and efficient operations of aeronautical systems; and develop and/or improve meteorological instrumentation and methods as needed to accomplish the first two objectives. Enhancement of Doppler lidar velocity signals will be investigated. The approach will be to continue to: (1) measure and analyze atmospheric data; (2) develop models of atmospheric boundary layer properties and conditions which lead to or intensify them; (3) perform analytical and field tests relative to investigating warm fog dispersal; and (4) develop and/or modify instrumentation as needed to meet requirements of this approach. To accomplish the objectives, the following 8 tasks will be performed: correlation of lateral and longitudinal gusts; atmospheric dynamics processes definition (including icing);

warm fog dispersal; characterization of atmospheric electrical phenomena; analysis of Doppler lidar measured wind; aviation meteorology workshop, bibliography and interagency meteorology retreat; new and/or improved instrumentation and methods for safety and efficiency of aeronautical systems; and interagency wind shear research.

W84-70103 **505-45-23**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS - SUBSONIC AIRCRAFT
R. E. Bower 804-827-3285
(505-45-43)

An advanced technology base will be developed to provide improved stall/spin characteristics for small and medium sized subsonic aircraft with both single and twin engines. The goal for this technology includes the development of test techniques and prediction capability. An experimental program will be conducted utilizing models and full-scale airplanes for both wind tunnel and flight testing. The experimental program will provide a data base and insight to guide the theoretical analysis, computer code development and simulator studies.

W84-70104 **505-45-14**
Langley Research Center, Hampton, Va.
AIRCRAFT LANDING DYNAMICS
R. C. Goetz 804-865-2042

The objective of the research is to measure the landing environment and the dynamic response of advanced landing systems to provide technology for safe economical all-weather aircraft ground operations. The scope of the effort includes investigation of the dynamics of tires and air cushions, braking and steering response of advanced systems, as well as definition of landing hazards such as runway slipperiness and tire blowouts. In FY-84, efforts to coordinate the National Tire Modeling Program will be emphasized. Based on new test data, software simulations will be developed of antiskid braking dynamics to support landing gear design and for application to aircraft ground-handling simulators. In air cushion landing system research, air cushion stability analysis will be refined. Work will continue to upgrade the Aircraft Landing Dynamics Facility to accommodate significantly higher landing speeds. Runway friction measurement research related to aircraft stopping performance will continue.

W84-70105 **505-45-30**
National Aeronautics and Space Administration, Washington, D.C.
RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)
Lee D. Goolsby 202-755-3000

This RTOP provides for the continuation of support to the Radio Technical Commission for Aeronautics (RTCA) located in Washington, DC. The RTCA brings together experts from government, universities, and industrial establishments to advance the art and science of aeronautics through the investigation of present and potential applications of avionics and telecommunications. The RTCA and its special committees seek solutions to problems involving the application of electronics, avionics, and telecommunications to aeronautical operations; they frequently recommend technical performance standards and common operational requirements for consideration by Government, industry, and aviation users. As a member of the Executive Committee, NASA's representative can present subjects or problems for discussion and action, authorize new special committees, and approve completed studies. Through the mechanism of RTCA, NASA can be kept abreast of aeronautical needs and requirements and can initiate relevant research and participate in development of solutions to common problems with other members of the aviation community.

W84-70106 **505-45-33**
Langley Research Center, Hampton, Va.
ADVANCED TRANSPORT OPERATING SYSTEMS
M. A. Burgess 804-865-2224

The objectives are to develop flight hardware, software, and display concepts enabling safe and effective operation in the evolving National Airspace System while more efficiently using fuel, airspace, and time; increasing traffic flow capacity; and improving operational capability in adverse weather. The approach is to: (1) propose and investigate improvements to flight deck design, ground and aircraft equipment, and procedures to provide more efficient operations; (2) develop improved takeoff, approach, and landing capabilities; (3) investigate methods to improve the exchange of information between ATC and aircraft throughout the flight profile; (4) identify and promote incorporation of aircraft capabilities in the design of ATC improvements to facilitate efficient operations; and propose and investigate strategies for optimization of terminal area traffic flow. This research involves analysis, simulations, and flight studies using facilities at Langley, Wallops, FAA Technical Center, and FAA-designated controlled airspace. Simulation facilities and the Transport Systems Research Vehicle (TSRV), a modified B-737 airplane equipped with flexible display and control systems, are used to study new hardware, software, and procedures in simulated and real ATC environments. The program includes active participation by major airframe manufacturers and cooperation with the FAA and airline representatives.

W84-70107 **505-45-43**
Langley Research Center, Hampton, Va.
AERODYNAMICS/PROPULSION INTEGRATION
R. E. Bower 804-827-3285

An advanced technology base will be developed for subsonic aircraft to improve safety and productivity, lower cost, and reduce performance losses that are associated with integration of propulsion systems and airframes. The technology base will be applicable to both military and civil subsonic aircraft, but will be focused on vehicles having operating characteristics and environments of large transport airplanes, commuter aircraft and general aviation airplanes. The research will involve analytical and experimental investigations beginning at the first level of integration (that is, wings-fuselages, wing-nacelles) and progressing toward more complete configurations with the objective to understand the behavior of attached and separated flows and assess the behavior in terms of its impact on performance and stability and control. The work will be accomplished through computer analysis, simulator studies, and wind-tunnel and flight tests of model and full-scale aircraft.

W84-70108 **505-45-63**
Langley Research Center, Hampton, Va.
LAMINAR FLOW INTEGRATION
H. T. Wright 804-865-3265

The broad objective of the Laminar Flow Integration RTOP is to develop the technology for practical, reliable, maintainable laminar flow systems for viscous-drag reduction of future transport aircraft. The technology developed will be focused on commercial transports, but will be applicable to military transports. Technology for laminar flow control (LFC), natural laminar flow (NLF), and hybrid laminar flow control (HLFC) will be developed. Under the NASA Aircraft Energy Efficiency (ACEE) program, candidate laminar flow systems concepts for application to future transport aircraft were defined and critical technology areas were determined that required further technology development efforts. Since FY-79, the LFC element of the ACEE program has continued to pursue development of these critical technology areas; ground and flight testing efforts have been initiated to evaluate leading edge systems, wing suction surface structures, and advanced airfoils. Ongoing parts of these efforts and additional efforts to further develop laminar flow technology with emphasis on optimal integration of LFC and NLF into an advanced hybrid laminar flow wing will be covered by this RTOP.

W84-70110 **505-45-72**
Lewis Research Center, Cleveland, Ohio.
AIRCRAFT SECONDARY POWER SYSTEMS TECHNOLOGY
A. C. Hoffman 216-433-4000

The objective of this program is the development of technologies that will allow the use of all-electric secondary power systems on aircraft in place of the current hydraulic and pneumatic systems. These technologies include advanced power-distribution systems, efficient and reliable power controllers, light-weight conductors, light-weight and efficient motors and generators, and zero customer-bleed jet engines. This program will be divided into four areas - technology evaluation, advanced material and device technology, advanced component technology, and component interaction testing. The technology evaluation will provide an assessment of the current state of aircraft power systems and identify the benefits associated with advanced technologies. Light weight conductors and magnetics as well as other devices will be developed in advanced material and device technology effort. These materials and devices will then be integrated into the designs of motors, generators, and controllers in the advanced component technology area. The behavior of these components, materials, and devices will be evaluated in a simulated aircraft power system during the component interaction testing. The Lewis program will be coordinated with efforts at Langley on electric flight-control systems in order that the final technologies could be the basis for an aircraft with an all-electric secondary power system.

W84-70111 **505-45-73**
Langley Research Center, Hampton, Va.
SYSTEMS ANALYSIS AND INTEGRATION STUDIES
R. V. Hood 804-865-3318

The development of a technology base for advanced electric secondary power systems, electro-mechanical actuators, fault tolerant digital flight controls and their systematic integration will allow aircraft designers more freedom in establishing configurations with improved performance and/or operational economics realized through weight and drag reduction. Work accomplished under this RTOP will establish technology research requirements for each of these subsystems based on an overall aircraft systems approach. Technology trades will be accomplished which account for subsystem interactions and potential applications (i.e., active controls). Extensive intercenter and interdisciplinary coordination is required to achieve these objectives. Results of this activity will be the basis for the preparation of an intercenter program plan for the Integrated Digital/Electric Airplane (IDEA) Program. Also to be examined is the feasibility of retrofiting an electromechanical actuator to the TSRV for DLC experiments and acquisition of general flight performance data.

Interdisciplinary Technology

W84-70112 **505-90-21**
Ames Research Center, Moffett Field, Calif.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
S. N. Davis 415-965-5113
(506-90-21)

The object of this RTOP is to support innovative and discretionary basic research in areas related to aeronautics. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics including the technical fields of aerodynamics, fluid mechanics, flight mechanics, power, guidance and navigation, applied mathematics, propulsion and man-machine integration. The OAST Research Council and the Ames Basic Research Council review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and the ABRC to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W84-70113 **505-90-22**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
Marvin E. Goldstein 216-433-4000
(506-90-12)

The objective is to conduct innovative, long-range, high risk, basic research in areas related to aeronautics. The program pursues basic investigations of, and facilitates exchange of information about new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics. The program is carried out primarily through grants which are selected by the Chief Scientist with the aid of the Research Advisory Board. It allows OAST to initiate fundamental studies in areas not presently included in a specific discipline program. The funds are also used to bring speakers and visiting university scientists to the Lab and to hold workshops and seminars.

W84-70114 **505-90-23**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
R. H. Tolson 804-865-2664
(506-90-23)

The objective of this program is to support basic research in universities in areas related to aeronautics through the funding of a limited number of unsolicited research proposals. University research proposals, that have been given high technical evaluations but are not funded through the research programs, are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA aeronautics programs.

Aeronautics Systems Technology Programs

W84-70115 **532-01-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT FLIGHT GUIDANCE SYSTEMS TECHNOLOGY
J. S. Bull 415-965-5425
(505-34-11; 532-06-11)

The objective of this research is to provide the critical technology needed to significantly improve rotorcraft operational capability under instrument meteorological conditions (IMC). The program goal is to achieve rotorcraft mission productivity under IMC conditions equivalent to that under visual meteorological conditions (VMC). The research program will be based upon the needs, requirements, and operating experience of the users, in coordination with the DOD, FAA, and industry. The design criteria and performance tradeoffs for rotorcraft all-weather system concepts will be defined, implemented, and evaluated through simulations, flight research, and operational flight assessments. There are three main rotorcraft all-weather system technology thrusts: (1) the development of design criteria and performance tradeoffs for promising remote site guidance concepts; (2) the definition of operational and performance limitations of curved, segmented, and decelerating rotorcraft approaches to a helipad in proximity to a Microwave Landing System (MLS) installation; and (3) the development of crew station design criteria for advanced all-weather integrated guidance and control system concepts.

Rotorcraft Systems Technology

W84-70116 **532-03-11**
Ames Research Center, Moffett Field, Calif.
RSRA FLIGHT RESEARCH/ROTORS
W. J. Snyder 415-965-6570
(532-06-11; 505-42-21; 505-42-61)

Research conducted under this program will provide and validate integrated rotor system technology required to substantially improve the performance, utility, efficiency, dynamics, noise, maintainability and ownership cost of civil and military helicopters. The objectives of this RTOP are to provide and validate integrated rotorcraft and rotor systems technology required for the low-risk design of advanced rotorcraft systems and components based on verified design tools and experimental methods. Program emphasis is on rotor system performance; rotor/airframe aerodynamics and aeroelastic methodology; vibration prediction and control; noise prediction and control; advanced materials application; advanced rotor control concepts; and advanced vehicle concepts which have significant potential gains in utility, efficiency, maintainability, and productivity. The activity involves system design studies and focused and coordinated research in analytical prediction methods, simulation, ground testing, and flight testing of current state-of-the-art rotors and advanced concept rotor systems. This program is in cooperation with U.S. Army utilizing the Rotor Systems Research Aircraft (RSRA) and other testbed aircraft as appropriate. The flight data base will be expanded on existing rotors that can be readily adapted for evaluation on RSRA (and other test rotorcraft) and adanced research rotor systems will be developed for evaluation. The development of the RSRA facilities will be completed and operation will be supported.

W84-70117 **532-06-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT SYSTEMS INTEGRATION
John D. Foster 415-965-6577
(505-42-11; 532-09-11)

Research conducted under this RTOP will advance rotorcraft aeromechanics systems technology with an emphasis on improving basic design theory, rotor and rotor/airframe aerodynamics, and aeroelastic characteristics and methodology; vibration prediction and control; noise prediction and control; and advanced control system concepts; advanced crew station concepts; and advanced vehicle concepts. The research involves focused and coordinated programs requiring analysis, wind tunnel model testing, simulation and flight testing. These programs encompass civil and military aspects of advanced rotorcraft concepts which will increase performance, efficiency, and productivity; reduce noise and vibration; and improve reliability.

W84-70118 **532-06-12**
Lewis Research Center, Cleveland, Ohio.
CONVERTIBLE ENGINE SYSTEM TECHNOLOGY
K. L. Abdalla 216-433-5175
(505-42-32)

Part of the NASA Rotorcraft Program is aimed at advancing technology in engine components, transmissions, and propulsion system integration. Objectives are to improve propulsion system durability, reliability, and cruise fuel consumption to reduce life cycle cost, to develop propulsion technology unique to high productivity vehicles, and to increase operational capability and flexibility. The objective of this program is to provide a research tool for the Government to determine the feasibility of and advance the technology for advanced high speed rotorcraft. Technology readiness will be demonstrated in an experimental propulsion system incorporating advanced engine concepts such as convertible engines, and advanced integrated airframe/engine controls systems.

W84-70119 **532-06-13**
Langley Research Center, Hampton, Va.
ROTORCRAFT VIBRATION AND NOISE
Robert C. Goetz 804-865-2042
(505-42-23)

The objectives of this research are to develop the technology for reducing the interior noise of helicopters through transmission/airframe isolation, to develop the technology for improving rotor noise methodology and a design to a noise criteria capability through the acquisition of acoustic data and development of noise prediction methods and to exploit the full potential of modern analytical techniques such as finite element modeling analysis for predicting and controlling the vibration characteristics of new rotorcraft vehicles during the design process. The noise and vibration work will be accomplished through a combination of major contractual efforts that involve all major U.S. manufacturers of helicopter airframes in parallel with in-house research. Contracted efforts on vibration characteristics will include coupled rotor-airframe analysis, modeling of difficult components, further development of FEM of both sheet metal and composite airframes, and advanced applications by the industry. Contracted efforts on noise include structural acoustics, basic aeroacoustic research, system elements development, further acquisition of noise data base and noise reduction technology developments.

W84-70120 **532-09-10**
Ames Research Center, Moffett Field, Calif.
RSRA/X-WING ROTOR FLIGHT INVESTIGATION
J. W. Lane 415-965-6576
(532-03-11)

The goal of this program is to adequately demonstrate specific X-wing technology such that this proof-of-concept flight investigation program coupled with the successful completion of the DARPA/NASA Convertible Engine Program and the DARPA/Army NOTAR Program would provide the necessary technology base such that a low risk development program could be initiated for an X-wing prototype vehicle. The X-wing is a four-bladed extremely stiff rotor utilizing circulation control aerodynamics for lift and rotor control, which is stoppable in flight. When stopped, the rotor/wing becomes two forward swept and two aft swept fixed wings in an 'X' configuration. For the X-wing flight experiment one rotor systems research aircraft (RSRA) will be configured as a compound helicopter using an X-wing rotor system driven by two GE T-58 engines that will also drive a compressor through a modified S-61 gearbox and clutch. A digital fly-by-wire flight control system will be developed to control the rotor utilizing higher harmonic control and hub moment feedback. This approach includes detailed analysis, design, fabrication, ground tests, and flight testing of an X-wing rotor system; modifications required to the RSRA; and supporting analysis, wind tunnel testing, and simulation.

W84-70121 **532-09-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED TILT ROTOR RESEARCH AND JVX PROGRAM SUPPORT
John Foster 415-965-6577
(532-06-11)

Current levels of military and civilian interest in tilt rotor applications provide the incentive and justification for NASA to continue with a program to advance the state-of-the-art for tilt rotor configuration optimization and to provide technology transfer support for on-going aircraft development (JVX). The goals of this effort are to provide simulation, wind tunnel, and flight test data support for the joint services JVX program and to provide for advanced tilt rotor technology development for subsequent tilt rotor vehicle applications. Flight test work includes military mission evaluation tests as well as terminal area and certification criteria development for the civil sector. Wind tunnel work is aimed at a more complete understanding of the vehicle aeromechanics and resultant vehicle optimization.

High-Performance Aircraft Systems Technology

W84-70122 **533-02-11**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FIGHTER TECHNOLOGY INTEGRATION/F-111 (AFTI/F-111)
Louis L. Steers 805-258-3158

The objective of this program is to conduct a series of experiments to verify in flight the predicted performance gains for the AFTI/F-111 mission adaptive wing. The flight experiments will verify the performance of active controls for load alleviation and reduced static stability incorporated in the AFTI/F-111 mission adaptive wing (MAW) aircraft. Dryden Flight Research Facility will operate the F-111 aircraft and conduct an investigation of the MAW as a part of the joint NASA-Air Force AFTI/F-111 program. Dryden will participate in design reviews, develop and operate instrumentation and define flight test plans.

W84-70123 **533-02-21**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED FIGHTER AIRCRAFT (F-15)
Berwin M. Kock 805-258-3164

The objective is to provide flight test support for high speed aircraft experiments. This will be accomplished by maintaining a baseline capability, with a high performance aircraft, that can be easily used to accommodate specific flight projects or experiments. The baseline support will include contractor maintenance support, instrumentation system operation, basic maintenance, and fuel.

W84-70124 **533-02-31**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
F-4C SPANWISE BLOWING FLIGHT INVESTIGATIONS
R. G. Bryant 805-258-3147

The overall objective is to verify, through full-scale flight tests with a modified F-4C airplane, the low speed and transonic performance and the flying qualities, improvements predicted by analytical and wind-tunnel studies or spanwise blowing. This program is a cooperative effort between Ames and Langley Research Centers. Factors not readily assessable in the wind-tunnel will also be evaluated during the flight tests. These include the use of spanwise blowing for improved maneuverability, control of low-speed wing rock, alleviation of shock-induced separation effects, and improved landing performance. Reynolds number and scale effects will be investigated.

W84-70125 **533-02-33**
Langley Research Center, Hampton, Va.
SPANWISE BLOWING
P. J. Bobbitt 804-865-2961

The objective of this research is to verify, through full-scale flight tests, the takeoff and landing and subsonic maneuver performance and flying qualities improvements predicted by analytical and wind tunnel studies for the spanwise blowing (SWB) concept. The research will also provide information to define the effects of vehicle configuration and flight regime on the optimum nozzle location, size, geometry, and blowing rate. The approach involves wind tunnel tests of an F-4 model in the NASA LaRC 7-by 10-Foot High-Speed Tunnel to obtain the necessary data to aid in definition of the flight experiments at DFRC. The wind tunnel tests will evaluate an outboard location for the SWB nozzles in addition to the inboard location currently on the airplane. Other leading-edge devices will also be tested in the tunnel to asses their effectiveness in controlling the leading-edge vortex flow.

W84-70126 **533-02-50**
Ames Research Center, Moffett Field, Calif.
PROPULSIVE LIFT TECHNOLOGY - QSRA FLIGHT EXPERIMENTS
Bedford Lampkin 415-965-6039

As demonstrated by the QSRA and supporting research activities, advanced propulsive lift technology can significantly increase lift and overall performance for a wide variety of military and civil aircraft operating in CTOL, RTOL, and STOL modes. Current research continues to confirm the premise that an optimally designed subsonic transport aircraft must feature some powered lift technology. This means that future opportunities for application of powered lift technology are essentially unbounded. The Propulsive Lift Technology Research program addresses these opportunities with a multi-discipline research program using the QSRA equipped with a digital computer, advanced electronic displays, and a programmable head-up display-supported by a comprehensive simulation and analysis program. Research will investigate aerodynamic performance and flight control systems including the application of propulsive lift to CTOL aircraft to reduce field length, increase payload at equal field length, or optimize other desired characteristics. Flying qualities criteria for highly augmented control modes will be defined and display concepts will be investigated for shipboard operations and military missions. Operating margin criteria will be defined for approach and landing. Design data for civil and military specifications and civil certification criteria for aircraft using this technology will be developed. Research activities include establishing landing field length for military and civil operations, as well as applying real-time energy management techniques for configuration management and flight profile generation. Maneuvering enhancement by the application of propulsive life will be investigated for noise abatement, fuel conservation, and military applications.

W84-70127 **533-02-51**
Ames Research Center, Moffett Field, Calif.
POWERED LIFT SYSTEMS TECHNOLOGY - HARRIER FLIGHT RESEARCH PROGRAM
Bedford A. Lampkin 415-965-6039

The Marine Corps will deliver the YAV-8B Harrier aircraft to Ames Research Center in the 2nd quarter of FY-84. A flight research program will be conducted in several phases at Ames Research Center and Dryden Flight Research Facility. The first flight phase, initiated in FY-84, will be conducted with essentially an unmodified aircraft to obtain a qualitative assessment of simulation results and the initial documentation appropriate for the development of parameter identification techniques. Following phase I, the aircraft will undergo modifications in preparation for the phase II flight research. Activities in FY-84 will also include pilot and maintenance personnel training, simulation investigations, and initial equipment procurement. McDonnell Aircraft Company is presently under contract to Ames Research Center to provide engineering and technical support for the YAV-88 research aircraft.

W84-70128 **533-02-61**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
AFTI/F-16
C. R. Jarvis 805-258-3311

The overall objective of the AFTI/F-16 program is to quantify the benefits and penalties of the individual and integrated technologies proposed to improve weapon system effectiveness and survivability by flight demonstration of air-to-air and air-to surface offensive and defensive mission roles. The digital flight control system (DFCS), automatic maneuvering attack system (AMSA) and pilot-vehicle interface (PVI) technologies are being implemented in a modified F-16 to allow flight evaluations of such non-classical control modes as direct lift and side force, flat turn, fuselage pointing, and uncoupled independent control of aircraft rotation and translation. The AFTI/F-16 airplane will be flight tested and evaluated by a joint Dryden, USAF and contractor flight test team and will be operated and maintained from Ames-Dryden facilities.

W84-70129 **533-02-71**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
DECOUPLER PYLON FLIGHT EVALUATION
M. R. Barber 805-258-3165
(533-02-23)

In order to obtain maximum utilization of fighter aircraft, many different types of combinations of stores are pylon-mounted to

the wings. The carriage of these stores can result in reduced flutter speeds or flutter placards with corresponding degradation in mission effectiveness. The NASA Langley Research Center (LaRC) has developed a pylon, the decoupler pylon, which suppresses wing/store flutter. The decoupler pylon dynamically isolates the wing from the store pitch inertia effects by means of soft spring and damper elements. Static pitch orientation of the store is maintained by a low-frequency control system. The decoupler pylon has been shown to be effective in suppressing wing/store flutter by analysis and wind tunnel tests on a rectangular research wing and in transonic wind tunnel tests on the F-16 and YF-17 flutter models. These results have been very encouraging and NASA has defined a program to flight test the decoupler pylon. A feasibility study and conceptual design have been conducted under contract establishing that the decoupler pylon concept can be implemented in flight hardware for testing on the F-16 aircraft. General Dynamics Inc. has fabricated a decoupler pylon for an F-16 aircraft under contract to LaRC. Flight tests of the decoupler pylon will be conducted under this RTOP.

W84-70130 **533-02-81**
Hugh L. Dryden Flight Research Center, Edwards, Calif.
FORWARD SWEPT WING (X-29A)
Walter J. Sefic 805-258-3145

The objective is to provide technical advisory support, conduct analysis, wind tunnel tests, simulations, ground facility tests and flight tests in order to discharge responsibilities established in the NASA/DARPA Memorandum of Agreement concerning the Forward Swept Wing Program. Dryden will provide technical support through participation in design reviews, independent analysis, ground tests, flight certification and readiness reviews, and through the implementation of a high fidelity real-time piloted simulation at Dryden. Dryden will also provide approval of quality assurance plans will provide proven flight test instrumentation from the Dryden inventory. Ames North will provide a high fidelity moving base simulation of the X-29A to study approach and landing characteristics.

W84-70131 **533-02-83**
Langley Research Center, Hampton, Va.
FORWARD SWEPT WING
P. J. Bobbitt 804-865-2961

The objective of this research is to conduct analyses, wind tunnel tests, simulations, ground facilities tests and flight tests on the forward swept wing as necessary to explore and evaluate advanced technologies. The research will provide high Reynolds number wind-tunnel data for correlation with flight data and will support prediction of stall/spin characteristics. The approach involves design and fabrication of a X-29A aircraft model for testing in the National Transonic Facility. The stall/spin research will include static and dynamic-force tests, dynamic model flight tests, and piloted simulation studies.

W84-70132 **533-02-93**
Langley Research Center, Hampton, Va.
ADVANCED HIGH-SPEED AIRCRAFT CONCEPTS
R. C. Goetz 804-865-2042
(505-45-23)

The objectives of the research conducted under this RTOP are to verify the load alleviation characteristics of active control landing gears through static drop tests and full scale flight tests, and to investigate the aeroelastic characteristics of oblique wings through wind-tunnel tests and analyses once aerodynamic and structural characteristics are defined. The approach includes the modification of a set of F-4C landing gear to incorporate active controls and static drop testing the gear at the Langley Landing Dynamics Facility. The modified gear will then be delivered to DFRF and installed on a USAF F-4C airplane for flight testing. The flight tests will include touchdown and taxiing operations over various runway surfaces, with and without the active control system being operational.

W84-70133 **533-04-12**
Lewis Research Center, Cleveland, Ohio.
TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST)
D. E. Sokolowski 216-433-6910

The overall objective of this effort is to improve durability prediction of combustor liners and turbine vanes and blades for advanced aircraft turbine engines. Life prediction systems will be made more effective by improving system elements which characterize fundamental behavior. These include models for high-temperature materials, aerodynamics, heat transfer, and non-linear finite element structural analyses. The effort consists of contracted and in-house research, both analytical and experimental in nature, in several technical disciplines. The analytical activities are those needed by industry and include computerized models that describe the environments and complex loading in hot section components of such engines. The experimental activities provide data required by the analytical models. In addition, experimental testing will enable demonstration of the validity of the models and the superiority over current methods.

Subsonic Aircraft Systems Technology

W84-70134 **534-06-13**
Langley Research Center, Hampton, Va.
TRANSPORT COMPOSITE PRIMARY STRUCTURE
H. L. Bohon 804-865-3081
(534-06-23)

The primary objective of the ACST program is to develop technology for and accelerate the introduction of composite material in wing and fuselage components of U.S. military and commercial transport aircraft. The program will provide generic design approaches and structural data required to achieve a level of technology maturity in the application of heavily loaded, post-buckled, strength critical, safety-of-fight composite structures to large transport vehicles. Currently contracts with the transport manufacturers to develop wing key technology on critical joints, fuel containment, and durability/damage tolerance will continue to completion. Study contracts to identify long lead technology considered vital to the efficient application of composites to fuselage structures were initiated FY-83. The successful completion of these programs in early FY-84 will pave the way for major multi-year technology contracts which will culminate with ground tests of moderately sized composite wing boxes and fuselage curved panel sections. The development of technology applicable to composite empennage structure will continue under an existing contract with a transport manufacturer.

W84-70135 **534-06-23**
Langley Research Center, Hampton, Va.
COMPOSITE MATERIALS AND STRUCTURES
R. C. Goetz 804-865-2042
(505-33-33)

The objective of this research is to develop the technology required to achieve the full weight reduction potential of advanced filamentary composites applied to airplane structures. Primary emphasis will be placed on understanding the fracture behavior of composites, particularly the rapid growth of damage induced by low-velocity impacts of loaded structure. Experiments and analytical studies will be used to relate material performance to constituent properties. Mechanisms of material toughening will be studied and the results used to guide new material development. Structural concepts for enhancing damage tolerance will be developed, analyzed, and verified through tests of panels and built-up structural components. The efficiency of bolted and bonded joints will be compared for both static and repeated (fatigue) loading. Concepts for efficiently and reliably joining composites will be developed. The cure mechanics of new resin systems will be studied and techniques developed to assure consistent quality of laminated parts.

Advanced Propulsion Systems Technology

W84-70136 **535-03-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP PROGRAM
G. K. Sievers 216-433-4000
(505-40-32)

The objective of the Advanced Turboprop Program is to develop propeller and related drive system and aircraft technologies critical to efficient, reliable, and acceptable operation of future advanced, high-speed, turboprop-powered aircraft. Both single-rotating and counter-rotating propeller systems and their technologies are being evaluated. A major emphasis in the program is the design, fabrication, and flight test of an advanced single-rotating large-scale propeller (9-foot diameter), powered by an available gas-turbine engine with a modified existing gearbox, to evaluate and correlate propeller structural integrity and cabin environment. Another major emphasis is the evaluation of counter-rotating propellers and their unique systems (e.g., engine systems). Supporting technology effort (analysis and tests) is conducted in the areas of propeller aerodynamics, acoustics, structures, and dynamics; aircraft cabin environment (both noise and vibration), and aircraft installation aerodynamics. Studies of advanced turboprop propulsion systems and components, and of advanced turboprop aircraft and their missions, are conducted to provide guidance to the technology efforts. NASA-Lewis Research Center has overall management responsibility for the program, but other centers conduct portions of the program that lie within their areas of expertise (e.g., Ames and Langley Research Centers: installation aerodynamic; Langley Research: cabin environment; Ames Research Center - Dryden Flight Research Facility: Near-field noise tests of sub-scale propeller models on JetStar aircraft.)

W84-70137 **535-05-12**
Lewis Research Center, Cleveland, Ohio.
SMALL ENGINE COMPONENT TECHNOLOGY PROGRAM
Carl C. Ciepluch 216-433-6644

The objective of this effort is to provide the advanced technology base needed to insure the technical advantage of U.S. manufacturers in the future small engine marketplace. The approach will be a two phase program to evolve, evaluate, and verify the needed advanced technology for gas turbine engines of 250 to 5000 SHP suitable for general aviation, commuter, and rotorcraft applications. Phase 1 will consist of: discipline research and technology; component research and technology; systems research and technology; and systems analysis and assessment studies. Phase 2 will consist of construction of one or more advanced technology verification test vehicles, and evaluation of promising concepts in an advanced technology engine environment. This overall approach will provide industry with the capability to design and build small engines with performance, reliability, maintainability, and durability approaching that of large engines.

Numerical Aerodynamic Simulation

W84-70138 **536-01-11**
Ames Research Center, Moffett Field, Calif.
NUMERICAL AERODYNAMIC SIMULATION (NAS) PROGRAM
F. R. Bailey 415-965-6419
(505-37-03)

The objectives of the NAS Program are to develop a NAS capability that will act as the pathfinder in advanced, large-scale computer system capability through systematic incorporation of state-of-the-art improvements in computer hardware and software technologies; provide a national computational capability, available to NASA, DOD, industry, other Government agencies, and universities, as a necessary element in insuring continuity leadership in computational fluid dynamics and related disciplines; and to provide a strong research tool for OAST. The NAS Program will consist of three major elements: the NAS Processing System Network (NPSN), the Numerical Aerodynamic Simulation Facility (NASF) to house the NPSN and support personnel, and the management and operation of the NPSN/NASF complex. This RTOP supports overall NAS Program planning, NPSN design, implementaton, integration and test. The NPSN development will be organized into three major phases in a building block approach: network prototype development; initial operating configuration development; and extended operating configuration development.

Space Research and Technology Base

Fluid and Thermal Physics Research and Technology

W84-70139 **506-51-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
V. L. Peterson 415-965-5265
(505-31-01; 506-53-31; 506-63-36)

The objective is to establish aerothermodynamic technology and configuration design concepts to improve vehicle safety, reliability, versatility, and aerodynamic efficiency with maximum payload for Earth-orbital missions and planetary exploration. Advanced computational methods and computer codes will be developed for predicting vehicle flow fields and performance. Flow models (used in these computer codes) will be developed from "building block" numerical and physical experiments. Aerothermodynamic studies will be performed of aero-assisted orbital transfer vehicles (AOTV) and advanced maneuvering entry vehicles. Flight data for existing reentry vehicles will be analyzed. New instrumentation techniques will be developed for the measurement of turbulence quantities in 3-dimensional flow fields. The use of the Shuttle Entry Air Data System (SEADS) will be investigated at subsonic and transonic speeds by the Dryden Flight Research Facility.

W84-70140 **506-51-13**
Langley Research Center, Hampton, Va.
ENTRY VEHICLE AEROTHERMODYNAMICS
G. D. Walberg 804-865-3887

The objective of this effort is to improve the fundamental understanding of aerodynamic and aerothermodynamic flow phenomena over entry vehicles in the continuum, transitional, and rarefied flow regimes. Results of this work will permit significant advances in the capabilities, reliability, versatility, and efficiency of future space transportation vehicles. The intent is to conduct fundamental and applied research using wind tunnels, flight data, and analytical techniques to expand the data base and the pertinent technologies beyond that established for shuttle. Specific studies will be directed toward the solution of aerothermodynamic problems associated with Earth-to-orbit and orbital-transfer vehicles, including aerodynamic performance, viscous-interaction and real-gas effects, vortex interactions, heat transfer, basic configuration shaping, and the development of computational techniques using both continuum flow and noncontinuum flow assumptions. These techniques will be applied to analyze the flows about complex, three-dimensional, high angle-of-attack configurations representative of advanced space transportation systems; the rarefied flow entry of aeroassisted OTV's to space-station drag, and to contamination from propulsion exhaust products.

W84-70141 **506-51-17**
Lyndon B. Johnson Space Center, Houston, Tex.
AEROBRAKING ORBITAL TRANSFER VEHICLE FLOWFIELD TECHNOLOGY DEVELOPMENT
W. D. Goodrich 713-483-3905

Flowfield simulations based on numerical solutions to the

equations governing 3-D viscous, compressible, reacting air have provided 'benchmark' heating and shock layer predictions for both the Orbiter thermal protection system (TPS) design and postflight data analysis. Although the experience gained in this advanced flowfield simulation capability for design purposes was a positive one, the complexity of the Orbiter flowfield challenged both the numerical and physical aspects of this capability. Because the severity of the environment, the stable temperature limitations of surface materials in this environment, and the anticipated complexity of an aerobraking orbital transfer vehicle (OTV) flowfield, the current flowfield capability will have to be revised to improved computational efficiency, accuracy, and physical fidelity which will help to enable a reusable TPS design. To this end, the objectives of this RTOP are: (1) update numerical algorithms for accuracy and efficiency; (2) determine production and rate of disposition of excited molecules formed in gas phase and from catalytic recombination on relevant TPS surfaces; and (3) determine effects of gas phase and surface reactions on heat flux on TPS surfaces for OTV. The approach will include numerical flowfield simulations that parametrically establish the sensitivity of heating rate predictions to varying chemical reaction assumptions, and laboratory experiments in flow tube reactors and arc jet facilities to establish reaction dynamics information. This information will be incorporated into the flowfield codes for use in establishing the most realistic heating environment and TPS design for an OTV.

W84-70142 **506-51-23**
Langley Research Center, Hampton, Va.
DETAILED AEROTHERMAL LOADS
R. C. Goetz 804-865-2042

The primary objective of this effort is to identify and understand flow phenomena and flow/surface interaction parameters required to define detailed aerothermal loads for structural design. The secondary objective of this effort is to develop and validate analysis and test methods for the prediction and verification of structural response in thermal environments for use in the support of design and qualification of aerospace vehicles. Effects of wavy surfaces, coves, gaps, protuberances, wing/body and wing/elevon junctions will be studied in wind tunnel tests. Selected problems will be studied analytically. Some effort will also be focused on mass addition cooling effects on flow phenomena with initial emphasis on conical shapes.

W84-70143 **506-51-41**
Ames Research Center, Moffett Field, Calif.
THERMO-GASDYNAMIC TEST COMPLEX
F. J. Centolanzi 415-965-5269

This RTOP covers the operation, maintenance, repair, and improvement of the facilities of the Thermo-Gasdynamic Test Complex. These facilities consist of: the Arc-Jet Complex; 3.5-foot Hypersonic Wind Tunnel; High Reynolds Number Channels; Ballistic Range Facilities; and the Electric Arc Shock Tube Facility. The objective of this effort is to provide aerodynamic and thermal testing in support of research and technology programs for NASA, Department of Defense, other government agencies, and industry. Program areas supported include generic research applicable to spacecraft thermal protection systems, planetary entry aerothermodynamics, fluid dynamics (including boundary layers) and experimental verification of various computer codes.

Materials and Structures Research and Technology

W84-70144 **506-53-11**
Ames Research Center, Moffett Field, Calif.
SURFACE PHYSICS AND COMPUTATIONAL CHEMISTRY
J. O. Arnold 415-965-6209
(505-37-01)

The objective is to develop a detailed understanding of the mechanisms which control important properties of matter over a wide range of environments. This understanding is leading to the development of new materials and processes needed by the agency. Work is proceeding in the areas of surface physics and computational chemistry. In surface physics, properties of metallic interfaces are being determined by probing their structure at the atomistic level. High lateral and depth resolution chemical analysis by Auger Electron Spectroscopy is used to measure the compositional structure of high temperature metallic corrosion scales. Knowledge of surface/environment interactions is being improved by studying chemisorption and surface reactions on macroscopic (single crystal) and microscopic (cluster) metal surfaces. Work is underway on the interaction of electron beams with gaseous adsorbates on well-defined metal surfaces. In computational chemistry, the physical and chemical properties of molecules and small atomic clusters (5-48 atoms) are being calculated using state-of-the-art wave function computer codes. These quantum mechanical results for the small atomic clusters are extrapolated by classical mechanics to determine surface and bulk properties of materials. Improvements in precision, code optimization and approximate methods are allowing larger systems to be studied, thus requiring smaller extrapolations to obtain surface and bulk properties. This also helps to elucidate the manner in which properties of atomic clusters approach those of the bulk material. These calculations are currently being used to investigate (and/or) model crack initiation and propagation, chemisorption, diffusion, corrosion, catalysis, and internal rotations and photo-oxidation of polymer chains.

W84-70145 **506-53-12**
Lewis Research Center, Cleveland, Ohio.
MATERIALS SCIENCE-NDE AND TRIBOLOGY
C. Lowell 216-433-6922
(506-33-12; 506-33-32)

The objectives of this RTOP are to develop greater understanding of materials with aerospace propulsion and power potential and to develop guidelines for improving their physical/mechanical properties and reliability. Fundamental studies are aimed at investigating mechanical and other factors that limit material reliability, performance, and useful life. Fundamental studies are also aimed at identifying scientific concepts that might be applied to substantially improve aerospace materials. Material properties/performance will be enhanced via innovative application of nondestructive evaluation concepts/models for characterization of microstructure and mechanical properties. This involves advanced nondestructive evaluation technology that goes beyond defect detection and characterization. The objective, therefore, is to develop technology for assessing material properties as well as diverse flaw populations that govern or influence mechanical behavior, reliability, and residual life. The basics of friction, wear, adhesion, thin film liquid lubrication, and the chemistry and morphology of solid lubricants will be studied. The work will focus on new tribological materials such as amorphous alloys (metallic glasses) and polycrystalline ferrites subjected to temperatures ranging from room to 800 C in terms of chemical, morphological, and tribological characteristics. The analytical and experimental results of both parts of this RTOP will have far reaching practical applications for a wide range of aerospace materials, structures, and components.

W84-70146 **506-53-15**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTALS OF MECHANICAL BEHAVIOR OF COMPOSITE MATRICES AND MECHANISMS OF CORROSION IN HYDRAZINE
Amitava Gupta 213-354-5783

This RTOP is divided into two tasks. The long turn objective is to develop a fundamental understanding at the molecular level of the behavior of polymers with major emphasis on candidate composite matrix materials. From correlations of molecular parameters with the observed mechanical properties, strategies will be developed for seeking molecular structures of polymers and composite systems with improved performance, life and cost. In thermosetting polymers, the FY-84 objectives are to complete the characterizations of the network topology and molecular

relaxation mechanisms of epoxy systems as a function of cure. The approach will involve sol/gel analysis and swelling measurements of the cured polymers, as well as characterization of birefringence and mechanical response as a function of strain as well as temperature and strain rate. In thermoplastics the objectives for FY-84 are to determine the physical aging effect on yielding and embrittlement of poly (methyl mechacrylate) (PMMA), and to characterize the molecular relaxation mechanism of high performance thermoplastic matrix material for high temperature applications. The approach will involve measurements of dynamic mechanical properties and birefringence, and molecular motion using electron spin resonance. The effects of microstructure, contamination, stress and alloy composition on corrosion tendencies of alloys in hydrazine will also be investigated. A test matrix has been established to study the effects of alloy composition, microstructure, and contamination of the propellant on the progress of corrosion caused by the action of hydrazine on metal surfaces using scanning electron microscopy and electron spectroscopy for chemical analysis. The data will be used to gain a fundamental understanding of the corrosion mechanism and to determine the kinetics of corrosion and the activation parameters.

W84-70147 **506-53-17**
Lyndon B. Johnson Space Center, Houston, Tex.
REFINING OF NONTERRESTRIAL MATERIALS
David S. McKay 713-483-3816

These studies are designed to provide data on chemical and physical processes which might be used to extract useful minerals, metals, and glasses from lunar rocks and soils for ultimate use in supporting space activities in near Earth orbit, in geosync orbit and on the lunar surface. Laboratory experimentation will be used to study some process by which potentially useful materials may be extracted from lunar rocks and soils. These studies will be confined to the laboratory scale at the bench-top level and will concentrate on the determination of basic physical properties which define and quantify processes. Our specific efforts are focussed on the separation of analogs to lunar soil and to actual lunar soil into their constituent mineral phases using both electrostatic and magnetic techniques. Additionally, appropriate size separation techniques will be developed and evaluated.

W84-70148 **506-53-23**
Langley Research Center, Hampton, Va.
SPACE DURABLE MATERIALS
R. C. Goetz 804-865-2042
(505-33-33; 505-33-23)

The objective of this reseach is to provide the technology necessary to assure the timely availability of materials for spacecraft, large-area space structures, and advanced space transportation systems. Current emphasis is being placed on establishing the performance capability of polymer films and composites in the radiation environment of space, characterizing the dimensional stability of metal and polymer matrix composites for space applications, developing concepts to provide thermal control coatings with tailored optical and electrical properties, and understanding the mechanical behavior of composites to improve their damage tolerance. Current and advanced polymer films and composites will be subjected to laboratory simulated space radiation (proton, electrons, UV, etc.) to establish overall material performance and to identify radiation damage mechanisms. These studies will serve as a guide to develop models to predict material performance in the space environment and to evolve more radiation resistant materials. Precision experimental and analytical techniques will be developed to characterize the dimensional stability of composite materials for spacecraft applications. Sputter coating techniques will be developed to tailor metallic/oxide thermal control coatings having desired emittance/absorptance and durability features. A generic methodology will be established for prediction of the fracture strength of composites as well as concepts to achieve improved damage tolerance.

W84-70149 **506-53-25**
Jet Propulsion Laboratory, Pasadena, Calif.
EFFECTS OF SPACE ENVIRONMENT ON COMPOSITES
Amitava Gupta 213-354-5783

The long range objective is to utilize fast pulsed particle (electron, proton, ion) beams and UV light sources along with advanced spectroscopic and analytical techniques to gain understanding of primary degradation processes caused by space radiation in polymeric and composite materials. This information, coupled with conventional exposure test data will be used to develop a reliable methodology for estimation of the long term effects of space environment on such materials. The objectives for FY-84 are to initiate development of a model for proton damage in epoxies, polysulfone and other candidate materials, to extend studies of the effects of UV radiation on polymeric materials into the vacuum UV region, to continue development of a model of the effects of energetic oxygen atoms on Kapton and other materials and to continue electron beam and proton beam radiolytic studies on epoxies, polysulfones and other candidate systems. Transient measurements utilizing fast optical and esr detection assemblies, following pulse radiolysis or UV excitation, will be used to identify transient intermediates and to determine rates of fast processes such as dissociation of primary intermediates, generation and decay of excited electronic states resulting from ion recombination or other secondary processes and radical formation and disappearance. These data along with other spectroscopic (Raman, FTIR, etc.) and analytical data will be used to develop models of degradation and a reliable prediction methodology for multiyear lifetime applications.

W84-70150 **506-53-26**
Goddard Space Flight Center, Greenbelt, Md.
ELECTRICALLY CONDUCTIVE THERMAL CONTROL COATINGS
John H. Henninger 301-344-5309

The objective of this RTOP is to develop advanced conductive thermal control coatings and coating techniques. The needed advancements have been established by consultation with industry, thermal design, experiment and materials personnel. Capabilities and facilities for development, evaluation, and qualification efforts are all currently active within the proposing Goddard Space Flight Center (GSFC) organization. The final products of this program will be definitive procedures and data for the preparation of coatings for space flight use, permitting private industry to act as suppliers. The proposed catagories of investigation are: (1) The development of composite vacuum deposited coatings on relatively thin, $< =$ 0.1 mil, polyamide films using several vapor deposition techniques. The final coating will be tailored to yield high solar reflectance and thermal emittance values to produce low alpha/epsilon ratios and with known sensitivity to contamination. (2) The development of new vacuum deposition procedures for enhancing the utilization of electrically conductive and transparent indium oxide coatings. The use of RF ion plating techniques and plasma tube ionization in conjunction with varying glow discharge rates will be evaluated. (3) The modification of existing GSFC formulations and applications relating to electrically conductive inorganic paints. The approach taken will be to optimize pigment size and attempt to improve vehicle conductivity at low temperature.

W84-70151 **506-53-27**
Lyndon B. Johnson Space Center, Houston, Tex.
HYPERVELOCITY IMPACT RESISTANCE OF COMPOSITE MATERIALS
J. L. Crews 713-483-5171

Composite materials are being used in spacecraft structures on an increasing scale. In orbit, these materials may be exposed to hypervelocity impacts with meteoroids and space debris at relative velocities of 20km/sec and 10km/sec respectively. Past research has defined the hypervelocity impact resistance of aluminum alloys, but little or nothing is known about the properties of composite materials. A series of tests are planned to define the hypervelocity impact properties of a number of composite materials and some simple structures made of the composites.

These tests will provide an engineering design criteria for the use of composites in structures exposed to the meteoroid/debris environment. Several materials will be selected for intensive tests, using a large light gas gun at Ames Research Center to impact projectiles up to 2 cm diameter at 10km/sec, and a small light gas gun at Johnson Space Center to impact smaller projectiles.

W84-70152 **506-53-29**
Marshall Space Flight Center, Huntsville, Ala.
SPACE DURABLE COMPOSITES AND THERMAL CONTROL SURFACES
A. F. Whitaker 205-453-8477
(506-53-23)

The objective of this RTOP is to provide advanced materials technology that will be necessary to assure successful development of future spacecraft, large-area space structures, and advanced space transportation systems. Major areas of investigation include extending environmental durability of materials to at least 10 years in both LEO and GEO, increasing durability and/or repairability of thermal control coatings, identifying significant damage mechanisms that degrade materials, and evaluating new and improved composites for environmental resistance. Two tasks, both ongoing, are being pursued under this RTOP to develop the technology needed in the areas of space environmental effects and durable/repairable thermal control surface. In the Space Environmental Effects on Materials task, development long-term space effects on materials will be continued. Metal matrix composites and other new technology materials will be added to the evaluation matrix. Predictive modeling of materials response to various environmental stimuli will be further developed. In the Durable/Repairable Thermal Control Surfaces task, work will be continued to develop thermal control surfaces technology to provide longer life, increased performance, on-orbit servicing, and improved particular and contamination resistance.

W84-70153 **506-53-31**
Ames Research Center, Moffett Field, Calif.
THERMAL PROTECTION SYSTEMS MATERIALS AND SYSTEMS EVALUATION
H. K. Larson 415-965-5369
(506-51-11; 506-63-36)

The objective is to provide thermal protection systems (TPS) concepts and materials for heat shields to protect Earth and planetary entry vehicles during atmospheric entry. The specific objectives are to develop concepts and materials for Aerobraking Orbital Transfer Vehicles and Advanced Military Spaceflight Capability; develop improved materials and minimum weight TPS to enhance the space shuttle and enable fully reusable advanced space transportation systems development; develop planetary probe and solar probe heat shield materials and determine methods to minimize heat shield weights; develop concepts and heat shield materials for safe Earth entry of radioactive power sources; support DoD requirements. The system requirements for each end use are defined. Thermal protection material parameters are determined that meet these requirements. Materials are either selected from the extensive technology in existence or new materials with optimized properties are developed. Candidate thermal protection concepts and materials are subjected to systematic analysis and testing to qualify them for the defined end use. Extensive unique Ames arc plasma test facilities developed for space shuttle and planetary entry probes are used in the experimental evaluations. Analytical studies are performed utilizing both the aerothermal environmental and material response to obtain in-depth understanding of the material characteristics. Materials are often developed as a result of these studies to meet the ever more stringent requirements for atmospheric entry thermal protection.

W84-70154 **506-53-33**
Langley Research Center, Hampton, Va.
THERMAL PROTECTION SYSTEMS FOR EARTH-TO-ORBIT STS
R. C. Goetz 804-865-2042
(506-53-43; 506-51-23)

The objectives of this research are to provide thermal protection systems materials and concepts for advanced space transportation systems that provide improved durability and operational costs compared to the current FRSI, LI-900 and LI-2200 RSI systems. Materials research includes development, characterization, and enhancement. Development efforts will be focused on fabricability of advanced carbon-carbon (ACC) and the characterization effort will focus on foil gage titanium, ODS alloys and superalloys, and thin gage ACC. Enhancement efforts will be focused on emittance, creep, oxidation and strength for titanium, superalloys, and ACC. Concepts research includes metallic pre-packaged and ACC post-supported standoff concepts. These concepts will be evaluated in various Langley high temperature wind tunnels and will be subjected to other types of tests such as foreign object impact and radiant heating. Arc tunnel and other facilities will be used as required to validate and certify TPS for multimission use. Heat shield testing support to the current STS program will be provided.

W84-70155 **506-53-40**
National Aeronautics and Space Administration, Washington, D.C.
ADVANCED SPACE STRUCTURES AND DYNAMICS
Samuel L. Venneri 202-755-2364

The objective of this RTOP is to develop a wide range of analytic tools and experimental techniques for use in the design, development, and analysis of the structures and structural dynamics of complex spacecraft and space structures. The program will be structured to foster innovative engineering solutions and design concepts for such vehicles. A number of key structural integrity issues will be addressed in order to develop the understanding and tools needed for the next generation of space structural design concepts.

W84-70156 **506-53-41**
Ames Research Center, Moffett Field, Calif.
TECHNOLOGY FOR LARGE SEGMENTED MIRRORS IN SPACE
R. Melugin 415-965-6530
(540-04-11; 159-41-01; 506-62-61)

The objective of this RTOP is the development of the technology required for the design fabrication, and test of lightweight mirror segments for large segmented mirrors in space. The Large Deployable Reflector (LDR), a prime candidate for this technology, is an orbiting 10- to 30-meter telescope for IR and submillimeter astronomy. Conceptual and systems studies for the LDR have identified top level drivers on the telescope such as aperture, primary mirror focal ratio and mass per unit area, and image quality. From these drivers, it was concluded that an assessment of lightweight mirror segment technology was needed. A study by Perkin-Elmer to assess the capabilities of existing mirror segment technologies identified basic characteristics and design requirements for LDR mirror segments as well as surveyed a wide range of currently available and developmental materials and several fabrication techniques. Characterization of mirror segment materials, fabrication, and test of subscale and full-scale segments will provide crucial data for the tradeoffs ultimately leading to the choice of the mirror segment technology for a proof-of-concept demonstration for the mission.

W84-70157 **506-53-43**
Langley Research Center, Hampton, Va.
ADVANCED SPACE STRUCTURES
R. C. Goetz 804-865-2042

Research will be performed on structures for future spacecraft including platforms, antennas, and space station and for future space transportation systems. In-house, deployable and erectable structural concepts and associated design technology will be

developed for large platforms and antennas. Folding and packaging techniques for very low-mass deployable structures will be investigated. Effects of using very slender members to achieve high packaging efficiency will be evaluated, and a slender-member truss structure will be constructed for static and dynamic tests. Studies of achievable accuracy will be conducted. In-house and contract research on structures for future space transportation systems will include fabrication of test panels for cryogenic tankage and small component testing of advanced carbon-carbon structure.

W84-70158 **506-53-45**
Jet Propulsion Laboratory, Pasadena, Calif.
LARGE DEPLOYABLE REFLECTOR (LDR) PANEL DEVELOPMENT
P. N. Swanson 213-354-3273
(159-41-01)

The objective of this RTOP is to continue the development of high surface precision structural composite reflector panels, based on results of the recent JPL accomplishments, for a class of antenna concepts for a large (10 to 30m) orbiting telescope for submillimeter and far infrared (50 microns to 1 mm) astronomy. Studies of submillimeter observatory concepts under RTOP 159-41-01 and results from a NASA sponsored workshop on Large Deployable Reflector (LDR) technology clearly identifies the reflector panel as a critical and enabling technology for LDR. The major contributions to reflector panels surface error include (1) manufacturing tolerances, (2) on-orbit thermal distortions and (3) long term material dimensional stability. The JPL is initiating development of LDR panel designs through a combination of materials characterization, structural/thermal analysis, thermal/vacuum testing of high precision graphite/epoxy panels, refinement of analytical models, and the determination of materials properties and configurations required to produce thermally stable structural composite panels. Preliminary results of this development will be available for the LDR workshop scheduled for the spring of 1985. The proposed approach for this RTOP is to continue the development of the thermally stable designs for graphite/epoxy panels through a combination of analytical modeling, fabrication, and testing. This would involve (1) initiation of composite materials laminate analysis, (2) initiation of constituent composite materials laboratory characterization, (3) thermal analysis, (4) initiation of structural analytical characterization, (5) initiation of procurement of high precision graphite/epoxy panels, (6) laboratory and thermal testing of characteristic small sample pieces of proposed panel design and (7) sample thermal/vacuum test.

W84-70159 **506-53-49**
Marshall Space Flight Center, Huntsville, Ala.
PLATFORM STRUCTURAL CONCEPT DEVELOPMENT
E. E. Engler 205-453-3958

Develop the integrated structural systems technology necessary to insure the capability to provide functional, primary and secondary deployable structural systems that support a (LEO) space station thrust. The work defined by this plan shall be constrained/bounded by the following parameters and considerations: The structural concepts developed will be STS (Shuttle) compatible for both transport and construction. The preferred method of construction will be deployable/erectable, i.e., deployable modules that may be assembled or erected into a variety of geometric forms. This method will enhance the evolutionary growth of large space systems. Structural concepts will be developed to accommodate two basic structural forms: (1) linear/area structures and (2) deployable volumetric structures. The premise is that area structure may be constructed from linear elements. The structural system concepts will be designed for deployment, assembly, operation, maintenance, and repair in LEO. The designs will be based on using an optimized mix of man (EVA) and machine for the construction functions. The goal of the program is to develop, demonstrate, and document (by 1986) evidence of advanced structures technology that will enable the capability of a space station mission.

W84-70160 **506-53-51**
Ames Research Center, Moffett Field, Calif.
STRUCTURAL ANALYSIS AND SYNTHESIS
A. L. Carter 805-258-3255

Experimental data from flight and laboratory tests of high temperature structures will be obtained and used to: (1) develop strain gage load measurement techniques for high speed flight vehicles; (2) evaluate state-of-the-art analytical methods for high speed flight vehicle; and (3) demonstrate new structural concepts for high speed flight vehicles.

W84-70161 **506-53-53**
Langley Research Center, Hampton, Va.
ANALYSIS AND DESIGN
R. C. Goetz 804-865-2042
(505-33-53)

The technical objectives are: (1) to develop advanced structural, dynamics and thermal analysis methods for predicting the nonlinear behavior of aerospace structures under mechanical and thermal excitations; (2) to develop and validate analysis and test methods for the prediction and verification of structural response in dynamic, acoustic, and thermal environments for use in the support of preliminary and advanced design, optimization, and qualification of space transportation systems and payloads, spacecraft and platforms; (3) to develop new analytical methods for predicting the coupled structural dynamics and control of multi-body space configurations; (4) to accomplish validated capability to control excessive responses of large flexible space structures by active and passive methods; (5) to develop mathematical algorithms for multidisciplinary optimization methods for aerospace structures. The work will be accomplished through in-house efforts with both contract and grant support.

W84-70162 **506-53-55**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE VEHICLE DYNAMICS METHODOLOGY
J. A. Garba 213-354-2085

The long-term objective is to perform basic research in structural dynamics and advanced mechanisms related to future NASA space missions. The research will focus on technology directly applicable to Space Station as well as methods for the improved prediction of low frequency payload dynamics using ground test and flight data. The objectives of the research in support of the Space Station type structural systems are to develop new methods for the analysis and synthesis of large complex structural systems. The approach will be to develop methods for the identification of structural parameters using flight measurements, investigate methods for the modification of structural parameters to improve the controllability, and to develop optimization methodology accounting for both structural and control parameters. The application of recent advances in computer technology to the analytical techniques will be investigated. Basic research in the development of advanced mechanisms for space station will be initiated in FY-84. The objectives of the low frequency dynamic payload response research are to reduce the cost of the STS payload integration analyses, to improve the accuracy of such analyses and to identify the requirements for research for future missions. The approach will be to improve methods for the prediction of upper bound payload member loads and to evaluate modern techniques for modal testing using a real complex space structure, the Galileo Interplanetary Spacecraft. The activities in this RTOP will be coordinated with NASA Headquarters, other NASA centers, the Dynamic, Acoustic and Thermal Environment (DATE) Working Group, the Space Systems Technical Advisory Committee (SSTAC), and related activities sponsored by the Department of Defense (DOD), specifically the Air Force (AF).

W84-70163 **506-53-56**
Goddard Space Flight Center, Greenbelt, Md.
PAYLOAD DEFINITION METHODS
J. P. Young 301-344-8284
(506-63-36)

The objectives are to: (1) develop a more efficient and less

costly technique for performing STS lift-off and landng flight loads analysis; (2) develop improved techniques for deriving vibroacoustic and related combined environment design and test criteria for STS payloads/components; (3) develop a software pre-processor program that will generate flexible body descriptive data for input into the DISCOS system dynamics analysis program. Structural impedance representations will be developed for the STS and payload in order to create a more cost-effective flight loads analysis technique. In addition, this technique will be designed to permit variations in payload stiffness, mass, or frequency in order to provide the ability to efficiently investigate the effects of these parameters on payload loads. The DISCOS program is to be enhanced by developing the most optimal technique for reducing the parameters that characterize a complex flexible body. By this technique, the total system dynamic properties can be optimally synthesized by the modal coupling process embedded within DISCOS. The VAPEPS program will be exercised, validated, and enhanced by incorporating a plot capability and operational data dictionary. A method for combining STS lift-off low frequency transient and vibroacoustic induced payload loads will be evaluated for cost effectiveness.

W84-70164 **506-53-57**
Lyndon B. Johnson Space Center, Houston, Tex.
MICROPROCESSOR CONTROLLED MECHANISM TECHNOLOGY
W. K. Creasy 713-483-2561
(506-64-27)

The objective of this RTOP is to evaluate and define the performance and design characteristics of microprocessor controlled space mechanisms. Laboratory tests of breadboard smart mechanism elements, including a variety of internal and external sensors, will be used to evaluate smart mechanism control stability, accuracy, and range. A prototype smart actuator, representative of station applications, will be fabricated and subjected to proof-of-concept ground testing.

W84-70165 **506-53-59**
Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE STRUCTURAL DYNAMIC ANALYSIS AND SYNTHESIS METHODS
R. S. Ryan 205-453-2481

The objective is to reduce the high costs and schedule delays due to structural dynamic response phenomena during the development of future spacecraft. Dynamics considerations have been critical for several recent NASA projects and are expected to be even more critical for future projects due to fundamental physical principles. Three tasks, both ongoing and new, are proposed for the development of improved prediction methods. In the improved structural and fluid dynamic analysis capability task, development of analysis methods to improve capability and usability will continue. The SPAR program is the basis of this work. Load combinations for design of STS payload components will be determined. Present methods are over conservative and no industry-wide standard exists. Very significant payload improvements should be possible. The properties of classical modes, complex modes, modes with closely spaced frequencies will be investigated and modes will be identified from tests.

Computer Science and Electronics Research and Technology

W84-70166 **506-54-10**
National Aeronautics and Space Administration, Washington, D.C.
ADVISORY GROUP ON ELECTRON DEVICES (AGED)
Martin M. Sokoloski 202-755-2494

The objective of this program is to provide effective coordination of NASA-sponsored research and development efforts on electronic devices and systems with similar work supported by DOD and other government agencies. Through full membership on the Advisory Group on Electron Devices and its constituent working groups, NASA program managers receive expert advice on the feasibility, currency, and soundness of planned R and D procurement activities, long ranging R and D requirements, complementary work in other government agencies, and forecasts of new technical developments.

W84-70167 **506-54-11**
Ames Research Center, Moffett Field, Calif.
PHOTOPHYSICS, OPTICAL INFORMATION PROCESSING AND NONLINEAR FIBER OPTICS
R. L. McKenzie 415-965-6158
(506-51-11)

The general objectives are: to incorporate modern laser technology and photophysics in a program to develop nonintrusive techniques for the characterization of gaseous media in a dynamic state, and to develop and evaluate optical computer processors and nonlinear fiber optics for advanced information processors to enable new space experiments, on board processing, and higher information and data transfer for space applications using integrated optical techniques. Activities will include the measurement of turbulent fluctuations in the state variables of cold transonic and supersonic wind tunnel flows, the spectroscopy of small molecules important in the photodiagnostics of cold air flows and combustion processes, the development of a programmable matrix mask for optical computing, the development of optically nonlinear fiber for the infrared beyond 4 micrometers, and the summing of mid infrared radiation into the visible for ultra-sensitive high-bandwidth detection of infrared photons. Furthermore, optimal information processor architectures will be defined.

W84-70168 **506-54-12**
Lewis Research Center, Cleveland, Ohio.
SUBMILLIMETER AND OPTICAL PROCESSING DEVICE RESEARCH
F. Teren 216-433-4000

The overall objective is to conceive and demonstrate techniques for high speed numerical calculation using electro-optic technology. Specific objectives include high speed solution of matrix equations with a hybrid electro-optical processor and laboratory demonstration of selected concepts for an all digital optical processor. Work is conducted through university grants and in-house analysis and experiments. Laboratory experiments are conducted using commercially available hardware such as acousto-optic modulators and liquid crystal light valves. An in-house design study of fast response spatial light modulators will be conducted. Another objective of this RTOP is to provide through research, design data and developments of materials and methods, the technology base for the development of voltage tunable local oscillator sources, capable of approximately one milliwatt output in the frequency range between 600 to 2000 GHz.

W84-70169 **506-54-13**
Langley Research Center, Hampton, Va.
SOLID STATE AND ELECTRO-OPTIC RESEARCH
R. L. Stermer 804-865-3777

The objectives of this research is to develop a technology base in advanced solid state and electro-optical devices to meet projected system needs for enhanced data transfer, processing, and data storage. Novel electro-optic devices and material concepts are to be evaluated to establish their viability in advanced space missions. Emerging data systems concepts to meet the operations and control requirements of a large space station and other proposed aerospace systems are to be used as guidance in developing devices. Special emphasis will be on developing advanced electronic and optical devices which will enhance system performance, and expandability/adaptiveness in a cost effective manner. A balanced approach to obtain the advantages of in-house research, grants, and research contracts is to be used. Theoretical and experimental investigations of device concepts, materials, and processing techniques will be conducted in-house. Contractual efforts will be used to develop the device concepts and technologies to a level of practical demonstration. Detailed measurement and analysis of device performance will be conducted in-house in

simulated system applications to supplement contractor measurements. This complementary effort in-house and contractual research is to be supplemented with university research to provide the scientific base to predict device performance over a wide range of applications.

W84-70170 **506-54-15**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTRONICS AND OPTO-ELECTRONICS RESEARCH AND TECHNOLOGY
E. D. Hinkley 213-354-6586

This RTOP develops enabling technology for NASA in the area of lasers, solid state devices, and optical processors through three major tasks. (A) Quantum Electronics (S. Trajmar,)-electron collision processes involving atoms and molecules (S. Trajmar) and ions (A. Chutjian) and causing optical radiation (S. K. Srivastava) will be investigated. Research concerning tunable laser sources for different regions of the spectrum: UV (J. Laudenslager), I.R. (M. Shumate), and submillimeter (H. Pickett and R. Bartman) will be carried out. (B) Solid-State Research (R. Maserjian,)-this task pursues two primary thrusts. The physics and chemistry of reliability subtask focuses on basic reliability problems of LSI technology such as radiation susceptibility. Advanced electrical and surface analytical techniques are developed and applied to determine cause-and-effect relationships between chemical processing and device degradation. The advanced solid-state devices subtask explore advanced device concepts using molecular-beam-epitaxy (MBE) to synthesize new modulated compound semiconductor structures (e.g., superlattices). Of particular interest are properties suitable for monolithic integrated optics. (C) Optical processing (S. T. Eng,)-this task consists of three subtasks: (1)electro-optic SAR data processor (T. J. Bicknell)-develop compact, high throughput data processing devices and systems especially for SAR data processing utilizing newly developed electro-optical devices; (2) parallel information processing with holographic interferometry (J. B. Breckinridge)-develop and evaluate innovative concepts for optical processors that can be used to manipulate large streams of data and provide solutions to control equations; (3) optical pattern recognition (A. Johnston)-investigate new techniques in real-time optical pattern recognition useful for objects with sample-to-sample variations.

W84-70171 **506-54-16**
Goddard Space Flight Center, Greenbelt, Md.
SIGNAL PROCESSING RESEARCH
Gordon Chin 301-344-5333

The broad objective of this program is to develop wide bandwidth, high resolution miniaturized acousto-optic spectrometers (AOS) for use as IF backends in tandem with heterodyne line receivers operating in the infrared, submillimeter, and millimeter spectral ranges. The miniaturized AOS will consist of a Bragg cell deflector which converts IF signals to ultrasonic waves, a source of coherent illumination such as gallium arsenide diode laser, an array of linear photodetectors, and associated optics and optic bench. The emphasis of the program is towards development of an AOS which is small, light weight, has low power requirements, and potentially rugged enough for space applications. The final phase of this program will include space qualification of a wide bandwidth AOS.

W84-70172 **506-54-17**
Lyndon B. Johnson Space Center, Houston, Tex.
PROGRAMMABLE MASK TECHNOLOGY
Harry Erwin 713-483-3660

Optical processing systems offer significant advantages for high speed parallel processing of data needed to support present and future NASA missions and thrusts. The inherent parallel nature of light makes high speed, small, integrated, optical processors possible. The immediate objective of the proposed effort is to develop reliable liquid crystal light value (LCLV) devices to achieve accurate and faster spatial modulation for the optical cross-correlation processing of data. At the present time, gallium arsenide and silicon have been used to demonstrate the feasibility of the LCLV devices. The effort under this RTOP will be directed to increase the reliability of these devices. Furthermore, the development of charge-couple devices (CCD) will also be undertaken. The CCD LCLV provides an efficient and flexible means of data storage for cross-correlation processing. The feasibility of LCLV devices has been investigated by Hughes Aircraft Company under U.S. Air Force (USAF) sponsorship. Available LCLV first-generation devices are presently being investigated for data correlation processing applications at JSC. This effort will be expanded in FY-85 to FY-86 to incorporate the newly developed LCLV devices for specific applications to the shuttle and space station data correlation processing.

W84-70173 **506-54-21**
Ames Research Center, Moffett Field, Calif.
FAR IR DETECTOR, CRYOGENIC, AND OPTICS RESEARCH
C. R. McCreight 415-965-6549
(506-62-21; 422-50-06; 159-41-01)

The objective of this RTOP is to develop advanced infrared detection systems for astronomical research. This program will provide the sensing and sensor support technology for low- and moderate-background applications throughout the infrared (IR) spectrum (2 to 200 microns). It will benefit programs such as the Shuttle Infrared Telescope Facility (SIRTF) and the Large Deployable Reflector (LDR). In the detector and detector array area, existing $<$ 30 micron arrays will be obtained and characterized, for eventual optimization for astronomy. Concepts for $>$ 30 micron arrays will be developed. Detailed laboratory characterizations will be followed by technology demonstrations on ground-based infrared telescopes. An additional objective is to develop a fundamental understanding of cryogenic systems and advanced optics. Besides SIRIF and LDR, this work is applicable to the space station, orbital transfer vehicles (OTVs), and Gravity Probe B (GP-B). Included are development of efficient means of long-term storage of cryogens in space, and advanced refrigerators for $<$ 1 kelvin cooling. The problems of mechanical mirror mounts, and the effects of thermal environments on mirror performance, will be addressed experimentally and analytically. In all activities, a blend of industry, university, and in-house expertise will be applied to the program.

W84-70174 **506-54-23**
Langley Research Center, Hampton, Va.
REMOTE SENSOR SYSTEMS RESEARCH AND TECHNOLOGY
B. A. Conway 804-865-3601

The objective of this research is to define, develop, and evaluate advanced sensor and sensor system concepts for the remote and in situ sensing of atmospheric and geophysical properties. Specific sensor technology areas to be investigated include advanced laser, electro-optic, and microwave concepts, and systems technology for passive laser heterodyne, broadband passive microwave, and active laser (LIDAR) systems. Systems-level laboratory and field demonstrations will be conducted to evaluate sensor technology applications to missions such as remote high-vertical-resolution measurements of atmospheric species, wind velocities measurement (shear, turbulence, species transport mechanisms), and determination of geophysical parameters (such as soil moisture or sea salinity). Research activities will be aimed at technology development for advanced airborne and spaceborne sensor systems, including large space antenna microwave radiometer systems.

W84-70175 **506-54-25**
Jet Propulsion Laboratory, Pasadena, Calif.
ACTIVE AND PASSIVE SENSORS RESEARCH AND TECHNOLOGY
E. D. Hinkley 213-354-6586

The objectives of this RTOP are to investigate design and develop: (1) passive and active microwave systems technology; (2) innovative laser systems technology; (3) infrared detector arrays; (4) innovative CCD array devices; and (5) pulsed high power lasers for altimeter applications; and (6) sensor cooling systems. The purpose is to exploit the unique properties of microwave and laser

technology for remote sensing of terrestrial, planetary and galactic environments and to investigate visible, UV, and IR detector array technology for future NASA missions. The approach is to complete in the FY-84: (1) the design and fabrication of a demonstration model of a distributed antenna for a synthetic aperture radar; (2) demonstration of detection of key atmospheric species in the lab with an excimer laser; (3) testing of 28 micron components in a heterodyne system configuration; (4) development of evolutionary CCD's which incorporate wide spectral band, on-chip motion compensation, ultra-low noise, and on-chip spectral filters; (5) feasibility demonstration of a high repetition-rate-transverse-discharge copper vapor laser; and demonstrate long-lifetime, closed-cycle cryogenic cooler operation.

W84-70176 **506-54-26**
Goddard Space Flight Center, Greenbelt, Md.
DETECTORS, COOLERS, MICROWAVE COMPONENTS AND LIDAR RESEARCH AND TECHNOLOGY
M. Mumma 301-344-6994

The objectives are: (1) to produce an array of high quantum efficiency high energy resolution X-ray detectors capable of imaging X-ray sources at energies above 1 Kev by utilizing deep diode technology; (2) to develop components for IR heterodyne spectrometers for use in the study of electromagnetic radiation from remote sources at wavelengths between 15 and 30 microns; (3) to develop advanced active laser sensing instruments in support of NASA programs in geophysics, climatology, and the atmospheric sciences; (4) to provide mechanical cooler and solid cryogen technology, which will be applicable to the large number of future missions that will require instrument cryogenic cooling; and (5) to extend previous work on ultra-sensitive coherent millimeter-wave detectors (mixers) into the submillimeter region, and to provide the technological base for submillimeter detectors approaching the ultimate quantum-limited sensitivity.

W84-70177 **506-54-27**
Lyndon B. Johnson Space Center, Houston, Tex.
MULTIFUNCTION SAR TECHNOLOGY
K. Krishen 713-483-5518

Synthetic aperture radar (SAR) systems provide night/day, nearly all weather, high resolution data not available with sensors in the other parts of the electromagnetic spectrum. The recent NASA/OSSA Global Habitability Program Plan identifies unique and complementary roles of SAR's in the biological cover/productivity assessment. The potential of SAR's for these applications can only be established in a limited manner with the presently available SAR capabilities which include single-frequency, single-polarization, and swath-widths up to 100 Km. The objective of the Multifunction SAR Technology Program is to develop technology for the fabrication of multimission spacecraft SAR's capable of operating at selectable frequency(ies), polarization(s), bandwidth, incidence angle(s), and wide swath with improved spatial resolution and calibration. The immediate goal is to conduct studies, design, fabricate, and conduct performance tests for advanced antenna systems, calibration subsystems, wide-swath SAR's, to allow fabrication of SAR systems with new functional and performance capabilities for missions planned for the 1986 to 1995 period. Demonstration of the new technology will be accomplished through laboratory, aircraft, or spacecraft testing on a subsystem level for the most efficient use of the resources. Other technology areas which include pixel elevation mapping, frequency agile/diversity SAR, phase/polarization mapping, will also be identified and prioritized for future development. All activities under this RTOP will be coordinated with U.S. Air Force in accordance with the Joint AF/NASA Space Based Radar/SAR Technology Program Plan.

W84-70178 **506-54-28**
John F. Kennedy Space Center, Cocoa Beach, Fla.
REMOTE SENSING OF HAZARDOUS GASES
Perry M. Rogers 305-867-3086

The objective is to advance technology in the use of laser remote sensing for the detection of toxic and explosive vapors. The proposed research is to investigate remote measurement of hydrazine vapors using differential absorption lidar (DIAL) techniques. The measurement is required to determine the concentration of hydrazines from the threshold limit value (TLV) to the lower explosive level (LEL). This research will provide parameters necessary to build prototype instruments for evaluation and certification of performance in and around launch vehicles, payloads, launch facilities, and storage areas. This initial research will be performed by the Jet Propulsion Laboratory Atmospheric Science Section for KSC Design Engineering (DE). Based on the findings of the JPL, DE will have a 'bread board' system built and tested in the laboratory which would provide additional information for the fabrication of a prototype system for field testing. The prototype instrument will be used to verify system design, develop operational requirements, and finalize the system configuration for construction of production instruments.

W84-70179 **506-54-50**
National Aeronautics and Space Administration, Washington, D.C.
AEROSPACE COMPUTER SCIENCE UNIVERSITY RESEARCH
Ronald L. Larsen 202-755-2395
(505-37-10)

The objectives are: (1) develop university-based center for aerospace computing technology, focusing on concurrent processing, highly reliable computing, and scientific and engineering information management; and foster cooperative, coordinated research coupling computer science with aeronautics, astronautics, and space sciences.

W84-70180 **506-54-55**
Jet Propulsion Laboratory, Pasadena, Calif.
COMPUTER SCIENCE RESEARCH AND TECHNOLOGY
T. Duxbury 213-354-4889
(506-58-15)

The objectives of this RTOP are to provide an agency foundation in fundamental computer science through research and experimentation, and to facilitate the infusion of state-of-the-art computer science and technology into aerospace applications; to provide the theoretical and technical base needed to develop advanced aerospace computing concepts and to evolve advanced system architecture in response to unique aerospace requirements; to provide advanced theory, concepts, techniques and capabilities for the effective use and management of aerospace information; and to provide state-of-the-art computational facilities for the conduct of research in computer science and technology for aerospace applications. The approach to meeting these objectives includes developing and understanding of the relationship and tradeoffs between algorithm and computer architectures; providing the theoretical and technology base for software development and information management systems; providing programming languages and techniques, software engineering methodologies and operating system concepts; providing scientific and engineering information management principals; and, investigating the theoretical basis underlying high reliability and fault tolerance of systems in order to provide insight into promising new architectural concepts for aerospace-related problems.

W84-70181 **506-54-56**
Goddard Space Flight Center, Greenbelt, Md.
COMPUTER SCIENCE RESEARCH
P. B. Schneck 301-344-9690

The objectives of the RTOP are to conduct fundamental research in computer science, demonstrate the potential of computer science for major agency programs, improve institutional facilities and resources, and develop close ties with industry and universities as research partners, beginning with the following specific objectives: (1) develop systems level software critical to the Massively Parallel Processor (MPP); (2) develop a theoretical base of knowledge and prototype implementation of derived methodologies, technologies, and systems required to handle very large multi-source databases managed at distributed locations; (3) extend current theoretical work in user level protocols to support the control and sharing of programs, information, and processing

resources, and in interfaces to represent network capabilities in terms meaningful to the user's problem environment; and (4) perform software management research leading to a well-defined operational structure termed the software management environment, including the creation of a technology assessment laboratory and the identification, evaluation, and development of software management tools, software design matrics, and approaches to rapid prototyping.

W84-70182 **506-54-61**
Ames Research Center, Moffett Field, Calif.
ADVANCED CONCEPTS FOR KNOWLEDGE-BASED EXPERT SYSTEMS
H. Lum 415-965-6544
(506-54-51; 506-31-01; 506-54-31)

Development of symbolic processing architectures, both hardware and software, required for spaceborne knowledge-based expert systems, will provide the impetus for automated spacecraft, space station, scientific instruments and ground-based stations. Use of spaceborne expert systems will result in more scientific return per unit dollar and minimum labor-intensive tasks. The research emphasis will be in the areas of spaceborne symbolic processing architecture, image understanding and information extraction techniques, and natural languages and interfaces. Overall end objective for the research effort is an image-based expert system for spaceborne applications. Early feasibility demonstrations will be conducted as major milestones are accomplished. In-house efforts which will benefit from the research include the Kuiper Airborne Observatory (KAO) Astronomy Program, Shuttle Infrared Telescope Facility (SIRTF), and Large Deployable Reflector (LDR). Cooperative research efforts with Standford, U. C., Berkeley, Carnegie Mellon University, Research Institute for Advanced Computer Science (RIACS), and industry including non-profit institutions such as SRI International are in progress. A Memorandum of Understanding (MOU) between ARC and GSFC to share and develop AI technologies has been negotiated.

W84-70183 **506-54-63**
Langley Research Center, Hampton, Va.
AUTOMATION SYSTEMS RESEARCH
A. J. Meintel, Jr. 804-865-2489
(506-57-23; 506-64-23)

The objective of this activity is to extend and enable the technology base required to design and automate teleoperator and robotic systems to enhance man's capabilities for future space activities including servicing, maintenance and repair, structural assembly, and space manufacturing. To achieve these objectives, the program focus will be to conceptualize, investigate, and verify algorithms, sensors, actuators, software, and system architecture required for remote space operations. The research will be conducted through simulation and laboratory hardware experimental tests. Parametric studies and analysis will be conducted to identify subsystem and component requirements. Controls research will include control modes, stability, time delays, trajectory optimization and evaluation of various levels of direct, shared man/computer, and supervisory control. Basic research on the application of adaptive control techniques for the control of flexible or 'limber' manipulators with distributed sensing and actuation will also be supported. The application of artificial intelligence techniques for atutonomous task planning, multiple system coordination, and monitoring and diagnosing the functioning of systems and subsystems will be evaluated.

W84-70184 **506-54-65**
Jet Propulsion Laboratory, Pasadena, Calif.
AUTOMATION TECHNOLOGY FOR PLANNING, TELEOPERATION AND ROBOTICS
S. Grenander 213-354-5854
(605-57-25)

The general objectives are to develop the technology base required in automated planning and decision making in the space program and to provide automated manipulation, sensing and actuation technology for future NASA teleoperation and robotics applications, such as satellite servicing, space assembly, and space contruction. The objectives of the unified process control automation effort are to identify, develop, and guide development and demonstrate techniques and technologies which have the potential of automating and unifying the design and operation of mission operations process control to assure significantly reduced cost, increased responsiveness and a higher degree of accuracy than is possible with currently applied techniques and technologies. The objective of the automated decision making/machine intelligence effort is to develop software tools that automate NASA mission operations functions which are now labor-intensive. The research areas are: (1) automatic generation of computer code by planning methods and concomitant automated scheduling (applied to mission command sequence generation); (2) automated fault diagnosis of spacecraft (applied to monitoring of telemetered data). In addition, assistance in using these tools is provided to the workers engaged in the uplink and downlink process control tasks of mission operations. The objective of the teleoperator and robotics task area is to advance technology in sensing, perception, and manipulation needed for future NASA missions utilizing teleoperators and robots. Included are subtasks: (1) interactive automation for teleoperators; (2) sensor based control languages; and (3) machine vision.

W84-70185 **506-54-66**
Goddard Space Flight Center, Greenbelt, Md.
AUTOMATION, MACHINE INTELLIGENCE, AUTOMATED PLANNING, SCHEDULING, AND CONTROL
D. S. Friedman 301-344-6242

The objectives are to demonstrate the feasibility of improving mission operations productivity and effectiveness by application of expert systems technology in a control center environment and to evaluate the further impact of higher levels of autonomy on the operational efficiency and effectiveness of ground-based control centers. The intent is to provide automated support to both operators and analysts; to expand the application of automation in the space program; and to provide NASA with the basic technology required for knowledge-based systems. The approach of this RTOP is to perform basic research in machine intelligence (primarily at Universities) and to perform development work on machine intelligence of a continuing relationship with an established research group in machine intelligence at a major university and the establishment of an in-house development group.

W84-70186 **506-54-67**
Lyndon B. Johnson Space Center, Houston, Tex.
AUTOMATED SUBSYSTEMS MANAGEMENT
A. F. Behrend 713-483-4823

Space station subsystems will require near autonomous control in order to reduce the demand on crew time and ground support personnel. Rapid, efficiently organized local and archival storage, retrieval and display of subsystem status, operation, and maintenance and repair information will be required across the various space station subsystems. The objective of this program is to develop and demonstrate the feasibility of generic automation techniques for the control of spacecraft subsystems using the advanced life support subsystem as the demonstration pilot subsystem.

Space Energy Conversion Research and Technology

W84-70187 **506-55-22**
Lewis Research Center, Cleveland, Ohio.
ELECTRIC PROPULSION TECHNOLOGY
Thomas H. Cochran 216-433-6897

The overall objective of this program is to conduct research on, and develop technology for, electric propulsion systems for future earth orbital and planetary missions. Applications include auxiliary propulsion for dense geosynchronous spacecraft and large space systems and primary propulsion for orbit change and transfer.

The kinds of propulsion systems considered will include ion thrusters, electrothermal rockets and electromagnetic devices. The program consists of analytical and experimental efforts. Mission studies will be conducted to establish the performance potential of specific propulsion concepts. Research will be carried out to understand basic physical processes and to establish the feasibility of specific approaches. Focused technology activities will be directed toward characterizing the performance, lifetime, and inerfaces of critical system elements such as thrusters and power processors. Work will be performed in-house, on contract, and with university grants.

W84-70188 **506-55-24**
Lewis Research Center, Cleveland, Ohio.
RESISTOJET SYSTEM TECHNOLOGY FOR SPACE STATION
Thomas H. Cochran 216-433-6897
(506-55-22)

The objective of the research is to define and provide resistojet thruster system technology for space station. Initially, selection of propellants for a high performance baseline thruster (300 to 700 sec Isp) will be based on space station system studies. Candidate propellants include hydrogen; hydrazine; and gases associated with manned systems such as methane, water, carbon dioxide, and nitrogen. Lab model thrusters will be used to determine performance, lifetime, and effluent characteristics. Finally, a system consisting of an engineering model thruster with other components of lab model maturity will be assembled and system performance and the operational interfaces characterized. A subsequent effort will be directed at developing the technology for an advanced system capable of operation in the 700 to 1000 sec Isp range.

W84-70190 **506-55-25**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTRIC/PLASMA ROCKET TECHNOLOGY
R. J. Vondra 213-354-3455

The long term objective of this RTOP is to perform fundamental research into the controlling physical processes involved in advanced plasma electric propulsion concepts. This will be guided by an identification of mission propulsion requirements and analytical studies to evaluate and identify which propulsion system technologies merit development. The FY-84 objective is to initiate investigations into advanced pulsed plasma thrusters for auxiliary propulsion applications requiring thrust on the order of several millipounds at specific impulses greater than 2000 seconds. In addition, research shall continue into the dependence of magneto-plasmadynamic (MPD) performance and life on physical, electrical and geometrical parameters with eventual application to steady state MPD design capable of pounds of thrust at 1000 to 2500 seconds specific impulse. Also, the identification, evaluation and selection of advanced propulsion concepts for potential future technical development will be made in FY-84. In FY-84 requirements for a pulsed plasma auxiliary electric thruster will be defined by a determination of projected mission requirements. Thruster designs based on this analysis will be built utilizing both gas and solid fuels and evaluated in terms of performance and life potential. In following fiscal years these designs will be refined leading eventually to flight development. Concurrently in FY-84, at Princeton University, research into the physical phenomena of quasi-steady MPD operation and performance shall continue with the eventual goal of improving operating in the steady state mode of operation. A continuing small program of contractor and in-house analytical studies and, where warranted, a basic research or proof-of-concept experiments will be used to evaluate and identify which new concepts merit technical development.

W84-70191 **506-55-42**
Lewis Research Center, Cleveland, Ohio.
PHOTOVOLTAIC ENERGY CONVERSION
H. W. Brandhorst, Jr. 216-433-4000

The objective of the RTOP is to improve conversion efficiency, reduce mass, reduce cost, and increase operating life of photovoltaic converters and arrays. Research and technology programs cover diverse areas. Emphasis will be placed on understanding radiation damage in gallium arsenide solar cells and exploration of means to reduce or heal this damage. Development of gallium arsenide solar cells for space applications will continue with special attention devoted to high efficiency cells designed for sunlight concentrator levels of 100 times in concentrator structures. In addition, efforts will continue to develop ultralightweight cells less than 10 microns thick. Efforts will also be continued on development of cascade cells made from III-V semiconductor materials and having the potential for 30 percent conversion efficiency. A concept utilizing surface plasmons will continue to be explored theoretically and experimentally. Welded solar cell interconnects for both planar and concentrator cells and arrays will be developed to achieve a reliable, low Earth orbit durable solar cell interconnect.

W84-70192 **506-55-44**
Lewis Research Center, Cleveland, Ohio.
PHOTOVOLTAIC ENERGY CONVERSION - SPACE STATION TECHNOLOGY AUGMENTATION
H. W. Brandhorst, Jr. 216-433-4000

The objective of this RTOP is to accelerate the development of photovoltaic technologies presently supported under the OAST generic technology base which are potential options for the space station power system. Augmentation is necessary to provide a sufficient data base on the performance of candidate technologies to allow consideration of these technologies for use on the space station. Augmentation will increase the number of component candidates from which selection of the power system for Phase C/D development can be made. The approach is to strengthen the relevant technology base efforts by initiating new work to further reduce risks.

W84-70193 **506-55-45**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH PERFORMANCE SOLAR ARRAY RESEARCH AND TECHNOLOGY
Paul M. Stella 213-354-6308

The long range objective of this RTOP is to develop and demonstrate high performance solar array technology capable of enhancing or enabling future NASA missions. As a goal this effort will demonstrate the feasibility of a 300 W/kg beginning-of-life (BOL) solar array for either high Earth or geosynchronous orbit (GEO) applications, and will establish a radiation data base for designing this array for end-of-life (EOL) mission requirements. The specific objective for FY-84, is to demonstrate, with hardware, all the necessary technology needed to design and build a 150 W/kg (BOL) solar array. A process will be demonstrated for manufacturing flexible substrate blankets composed of welded ultrathin silicon solar cells protected either by ultrathin covers or a space stable encapsulant. The efficiency and temperature performance of the solar cell will be optimized to increase the specific power of the blanket to 500 W/kg. A lightweight, high strength array structure expressly designed for high performance blankets will be demonstrated and then integrated with the blanket

to provide an array which has the potential to achieve > 300 W/kg BOL in a geosynchronous or high Earth orbit.

W84-70194 **506-55-48**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-KW CONCENTRATOR SOLAR ARRAY - SPACE STATION AUGMENTATION
M. R. Carruth, Jr. 205-453-4275
(506-55-49; 506-55-42)

The objective of this RTOP is to develop the preliminary design of a concentrator solar array wing. The miniature cassegrainian solar array utilizing GaAs solar cells is the concentrator approach which will be employed. Various concepts of solar array wing design and deployment will be evaluated including deployable as well as erectable designs. An approach will be selected based on technical feasibility, minimum complexity, low cost, and low risk. A preliminary design of this approach will be produced. Prototype hardware will be built and tested to verify the design and predicted performance.

W84-70195 **506-55-49**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-KW SOLAR ARRAYS
M. R. Carruth 205-453-4275

The objective of this RTOP is to advance the state-of-the-art in multi-kW solar arrays for Earth orbit; it is necessary for support of future NASA missions such as the Space Station. This RTOP will be a combination of in-house and contracted efforts and will consist of the following tasks: (1) low cost multi-100 kW solar array concept and technology development; (2) investigation of theoretical concepts for power generation; (3) materials evaluations for Earth orbital solar arrays.

W84-70196 **506-55-52**
Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE
L. H. Thaller 216-433-5260

The objective of this RTOP is to attain long life, high energy density, high reliability and lower cost electrochemical storage and conversion devices. The emphasis is on devices that will be required for future space missions. The current focus is on technology for Space Station applications. This emphasis will be conducted within the framework of multiyear plans which take into account the needs of user groups and the efforts of other NASA Centers as well as the Air Force. The approved Nickel-Hydrogen Plan and the Fuel Cell Plan, now in the final stages of review, describe the task areas and major milestones for these coordinated efforts. The work in nickel-hydrogen aims at firmly establishing the component technology of current cell designs as well as investigating advanced cell design concepts applicable for multi-kilowatt systems. The ongoing technology efforts in alkaline hydrogen oxygen fuel cells and water electrolysis will continue to emphasize combined fuel cell water electrolyzers for large low Earth-orbit energy storage applications. The in-house efforts relate to electrode, separator, and component technologies to support these two major parts of the multi-kWh storage effort. Chemical compatibility and pore size engineering of cell components are key. Synthetic battery cycling and system assessments continue to provide guidance to the program. Preliminary reviews and exploratory experimental studies will be carried out on the more advanced electrochemical and mechanical storage concepts.

W84-70197 **506-55-54**
Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE - SPACE STATION TECHNOLOGY AUGMENTATION
L. H. Thaller 216-433-5260

The objective of this RTOP is to accelerate the development of electrochemical power technologies presently supported under the OAST generic technology base which are potential options for the space station power system. Augmentation is necessary to provide a sufficient data base on the performance and life cycle cost characteristics of candidate technologies to allow consideration of these technologies for use on the space station. Augmentation will increase the number of component and subsystem candidates from which selection of the power system for Phase C/D development can be made. The approach is to strengthen the relevant technology base efforts by adding funds to specific existing contracts, and in some cases, by initiating new work to further reduce risks.

W84-70198 **506-55-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED ELECTROCHEMICAL SYSTEMS
I. Stein 213-354-6048

The overall objective of this RTOP is to achieve improved performance, energy density and lifetime of space batteries for applications in Earth orbital and interplanetary missions. Objectives for each of the three tasks are as follows: (1) advanced electrochemical storage cell concepts - to explore the feasibility of using new electrochemically-active polymeric components in high power, high energy density cells; (2) primary lithium batteries - FY-84 objectives are to develop prototype cells, establish performance and safety of these cells, and implement an accelerated storage life test program; and (3) secondary lithium batteries - FY-84 objectives are to complete the assessment of cycle life-related performance and degradation characteristics, to evaluate new high energy density cathode materials, and to develop improved electrolytes capable of sustaining high voltage, high rate operation. The approach will be to: (task 1) conduct basic chemical, physical, and electrochemical measurements of advanced electrochemical components and to assess the spaceworth of novel advanced battery concepts; (task 2) initiate operations in prototype cell facility and fabricate cells, establish chemistry in, and electrical performance of evolving designs of prototype cells, and initiate microcalorimetric as well as elevated temperature accelerated storage life test on cells; and (task 3) conduct studies to evaluate new high energy density cathode materials (other than TiS2) with attention given to the use of nonactive dilutents and develop improved electrolytes with emphasis on solute stability and synthetic passivation.

W84-70199 **506-55-57**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL ENERGY STORAGE AND POWER SYSTEMS
J. Dale Denais 713-483-2783

The objective of this research effort is to advance fuel cell and electrolysis cell technologies, to mature and integrate them into a Regenerative Fuel Cell system, and demonstrate the system for low Earth orbit applications. Maximized efficiency, high energy density, and long life are primary technical objectives. An interim test will be conducted on integrated breadboard-type hardware of about three kilowatts to verify concept feasibility. This will also serve as a test bed to help define technology limitations and to evaluate interaction phenomena of dissimilar fuel cell/electrolysis cell concepts. Flight experiments and/or engineering model hardware will be fabricated which incorporates all technology advances for demonstration of technology readiness. The results will provide a basis for selection of the Regenerative Fuel Cell over other potential concepts for large orbital energy storage systems.

W84-70200 **506-55-58**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL ENERGY STORAGE AND POWER SYSTEMS SPACE STATION AUGMENTATION
J. Dale Denais 713-483-2783
(506-55-57)

The objective of this research and development effort is to advance the fuel cell and electrolysis components to a 40,000 hour plus life. Components refers to the accessory section (pumps, valves, regulators, etc.) and not the electrochemical cells which make up the fuel cell and electrolysis stacks. NASA is presently developing the acid and the alkaline regenerative fuel cell (RFC) concepts for usage as the energy storage system in space station. Both of these concepts require research, design development and/or testing to demonstrate reliability and long life.

W84-70201 **506-55-62**
Lewis Research Center, Cleveland, Ohio.
SP-100 AND STIRLING
R. J. Sovie 216-433-6793

In scope the SP-100 program has the DOD, DOE, and NASA charter for all space nuclear reactor power systems technology development. The project office established at JPL manages all SP-100 technical work during the initial, technology assessment and advancement phase. In this phase, the project will develop nuclear and aerospace technology; evaluate NASA, commercial and military missions; and develop system designs. This phase ends in FY-85 with the selection of a specific system for the second, engineering feasibility test phase. The LeRC will provide support to the project office on the conceptual designs of advanced conversion technology systems for use with nuclear heat sources, nuclear power systems analysis, space station mission applications, launch vehicle requirements, and technology development of dynamic and advanced systems.

W84-70202 **506-55-65**
Jet Propulsion Laboratory, Pasadena, Calif.
THERMAL-TO-ELECTRIC CONVERSION
V. C. Truscello 213-354-7956

In scope, the SP-100 program has the DOD, DOE, and NASA charter for all space nuclear reactor power systems technology development. The project office established at JPL manages all SP-100 technical work during the initial, technology assessment and advancement phase. In this phase, the project will develop nuclear and aerospace technology, evaluate NASA, commercial and military missions, and develop system designs. This phase ends in FY-85 with the selection of a specific system for the second, ground test phase. The objective of the RTG (Radioisotope Thermionic Generator) conversion technology task is to identify and evaluate those material properties which are predictive in character, and thus will guide the choice and tailoring of new improved thermoelectric materials for energy conversion. The objective of the advanced technology task is to identify and evaluate the feasibility of innovative advanced concepts in the areas of energy collection, conversion, transmission and storage. Feasibility is defined as: (1) an understanding of the basic physics of the concept; (2) a demonstration of key performance parameters; and (3) an understanding of the system implications of the concept.

W84-70203 **506-55-72**
Lewis Research Center, Cleveland, Ohio.
POWER SYSTEMS MANAGEMENT AND DISTRIBUTION
R. Bercaw 216-433-6143

The objective of this RTOP is to provide the technology base necessary to control the generation and distribution of energy in future space systems and to assure their environmental compatibility. The proposed work will define and develop the generic technology to enable large multikilowatt power systems in space. In-house and contractual studies will be conducted, as needed, to determine performance requirements, system constraints and new technology needs for future space power systems. Contract, grant, and in-house experimental and analytical programs will be conducted to explore the basic physics of conductor, semiconductor, insulator, dielectric, magnetic and thermal materials for power devices; develop an analytical model of their operating principles; and to demonstrate their performance in experimental devices and circuits as required. In addition, this program will perform ground tests to simulate and determine the impact of the environments on space systems, develop models of the physical phenomena and conduct space tests to verify ground test data. Discrete components developed under the program (such as remote power controllers, rotary power transfer devices, high voltage transmission lines, etc.) will be evaluated in a power system test bed facility to measure their performance and interactions in an integrated system.

W84-70204 **506-55-73**
Langley Research Center, Hampton, Va.
ADVANCED SPACE POWER CONVERSION AND DISTRIBUTION
E. J. Conway 804-865-3781

Advanced conversion and distribution research includes both concept evaluation for space power technology of the future and also the research needed to achieve significant technical advances. Through these efforts, promising concepts are systematically explored, and the critical technologies fundamental to feasibility are generated. The research develops the understanding required to advance NASA power and propulsion capabilities to explore and use space. Application of new power technologies could revolutionize advanced space stations, orbital transfer vehicles, and space manufacturing platforms. Program objectives are to assess advanced concepts for space energy generation, conversion, storage, and distribution; and to develop the key technologies required to determine scientific feasibility. This includes investigating (1) direct conversion of thermal and solar energy into laser radiation; (2) generating and investigating novel means to convert solar and laser radiation efficiently to electricity, or other useful forms of energy; and (3) assessing the technology status and potential applicability of known and proposed advanced conversion concepts, and demonstrating feasibility of selected technologies. This program combines experimental and theoretical efforts. Research is performed in-house and on grants and contracts. It is composed of three efforts--lasers, converters of radiant energy to electricity, and new concepts such as high-current switch and a liquid droplet thermal radiator. The core of the program is in-house.

W84-70205 **506-55-75**
Jet Propulsion Laboratory, Pasadena, Calif.
ENVIRONMENTAL INTERACTIONS R & T
P. A. Robinson, Jr. 213-354-3882

The general objective of this RTOP is to develop the technology for controlling space plasma interactions with large and high voltage spacecraft surfaces. The long range plan of this ground investigation is to determine and model the plasma phenomena and then extrapolate these results to system performance in the space environment. This activity is part of a joint AF/NASA comprehensive research and technology program. This technology will be required to provide design information for large spacecraft and high power modules. The design of a space station will require this technology base, both because of its size and use of high power modules. Specific objectives for FY 84 will include: (1) develop analytical models of the low Earth/low latitude cold plasma environment; (2) determine the area scaling of the RF spectra generated during arc discharges; (3) measure the RF spectra of arc discharges for different sample configurations; and (4) RF model development. Specifically, this effort will furnish information on the low energy plasma environment near the Earth, determine the effects of charged particles on spacecraft and solar array surfaces, and provide a model to explain the physical process of RF generation in arc discharges. The approach will be divided into two major tasks: Environmental modeling will address the RTOP objective by developing time dependent analytical models of the near Earth plasma environment by end of FY-84. RF characterization of Arc discharges will address specific objectives by experimentally characterizing the RF spectra of arc discharges for spacecraft materials of different surface areas and under different configurations, and by developing a model of RF generation with the acquired data.

W84-70206 **506-55-76**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED POWER SYSTEM TECHNOLOGY
L. W. Slifer 301-344-8841

The basic objective for this RTOP is to convert advanced power technology R&D accomplishments at the various NASA centers and at other agencies (DOD, DOE) to a state of readiness for future flight applications. The approach includes the overall assessment of R&D status, the evaluation of technology advancements in terms of potential for flight application, the completion

of engineering development necessary to bring high-potential advancements to technology readiness, and the analysis of power systems incorporating the advanced technology. The RTOP consists of five tasks: (1) power technology assessment; (2) analytical modeling of power systems; (3) assessment of nickel-hydrogen cell technology; (4) development of spacecraft power system utilizing inertial (flywheel) energy storage; and (5) forecasting of high voltage insulation performance.

W84-70207 **506-55-79**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-100 KW LOW COST EARTH ORBITAL SYSTEMS
J. R. Graves 205-453-2514
(506-55-62; 506-64-19)

The objectives of this RTOP are to develop and evaluate high voltage, multi-100 kW power system control and distribution requirements and technologies which show potential for reducing space energy costs through improved efficiency, life, and/or reliability. These objectives will be accomplished via a combination of in-house and contracted efforts and will consist of developing control and distribution hardware and technqiues and constructing a system breadboard for verification and evaluation of new technologies and power management techniques. These tasks will be coordinated with the space platform studies conducted under RTOP 506-64-19.

W84-70208 **506-55-80**
National Aeronautics and Space Administration, Washington, D.C.
SPACE ENERGY CONVERSION SUPPORT
J. H. Ambrus 202-755-3127

The objective is to provide support to the Headquarters operation of the OAST Space Energy Conversion Program. This will include: (1) operation of the multiagency supported Power Information Center of the Interagency Advanced Power Group; (2) support to the Civil Missions Advisory Group; and (3) analytical efforts in support of space energy conversion technologies.

W84-70209 **506-55-82**
Lewis Research Center, Cleveland, Ohio.
THERMAL MANAGEMENT
D. T. Beanatowicz 216-433-6143

The objective of this RTOP is to develop the thermal management technology required for future high power space systems. Radiator concepts having the potential for dramatic performance improvements over fluid and heat pipe radiators will be identified and their basic feasibility demonstrated. Currently the Liquid Droplet Radiator (LDR) and the Liquid Metal Belt Radiator (LBR) have been identified and are under active investigation. Two phase fluid heat transport systems combine the potential for dramatic reductions in mass and parasitic power with improved temperature control. A second part of the effort will provide the technology base needed to design two phase systems which operate under reduced gravity. The work will be accomplished through a combination of contracted efforts, university grants and in-house analysis and experiments. The in-house projects will utilize existing LeRC facilities such as high vacuum chambers, the zero gravity facility, and airplanes. When appropriate, in space experiments using the facilities made available by the Space Transportation System will be identified, planned and carried out. The feasibility of the LDR is being demonstrated through a cooperative, dependent program with the Air Force.

W84-70210 **506-55-83**
Goddard Space Flight Center, Greenbelt, Md.
THERMAL MANAGEMENT FOR ADVANCED POWER SYSTEMS AND SCIENTIFIC INSTRUMENTS (SPACE STATION AUGMENTATION)
Stanford Ollendorf 301-344-5228

The objective is to develop and test analytical tools, control systems, thermal storage devices, and components which transfer heat across boundaries for application to power systems and scientific instruments on space station. The approach will be to: (1) develop analytical models of two-phase heat acquisition and transport systems which can be used for design, test verification, and control; (2) to build and test heat exchangers and flexible heat pipes for interfacing with space station users; and (3) to investigate candidate two-phase energy storage systems for thermal load leveling. In FY-84 it is expected that analytical models will be assembled and verified using laboratory results; breadboard level devices for interfacing with users will be built and tested; and selection of candidate energy storage systems will be made.

W84-70211 **506-55-86**
Goddard Space Flight Center, Greenbelt, Md.
THERMAL MANAGEMENT FOR ADVANCED POWER SYSTEMS AND SCIENTIFIC INSTRUMENTS
Stanford Ollendorf 301-344-5228
(480-10-31)

The objective is to develop and test heat acquisition and transport systems for application to power systems and for temperature control of scientific instruments. The approach will be: (1) to design, analyze, fabricate and test various two-phase flow devices in order to evaluate their potential; (2) to select candidates and supporting components for prototype development; (3) to test as subsystem with appropriate controls and interfaces; and (4) to develop small flight experiments to study the problems associated with two-phase flow.

W84-70212 **506-55-87**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT FOR ON-ORBIT ENERGY SYSTEMS
W. E. Ellis 713-483-2351

The objective of this RTOP effort is to: (1) develop the technology necessary for thermal management of a large Space Station; (2) extend orbital lifetime capability of themal management systems from months to several years; (3) provide the technology necessary for high energy density heat collection and transport; and (4) reduce the complexity and thus cost of very large scale heat rejection systems by orders of magnitude. This will be achieved by establishing the technology for the design, fabrication, and test of hardware comprising a representative portion of a full scale system. Such a system might consist of a pump assisted two phase flow circuit providing a constant temperature thermal bus or energy transport loop that would deliver or receive heat to/from the various subsystems and payload heat sinks or sources via one or more types of modular (i.e., easily connectable/removable) thermal interface devices (contact heat exchangers, fluid or heat pipe quick disconnects, etc.). The primary heat sink for such a system could be made up of relatively simple independent radiator elements containing large, high capacity dual passage heat pipes that would provide a space constructable radiator system with long life due to low system vulnerability to the micrometeoroid environment.

W84-70213 **506-55-88**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT AUGMENTATION FOR SPACE STATION
W. E. Ellis 713-483-2351

The objective of this RTOP is to develop alternate thermal control concepts and potential enhancements to complement and augment the base technology activities defined by the RTOP for 'Thermal Management for On-Orbit Energy Systems' (506-55-87). Effort will be directed toward developing technology alternatives that satisfy the unique space station thermal management requirements of evolutionary growth, long life heat rejection, and 'user friendly' thermal acquisition and transport. In the area of heat rejection, concepts will be developed for; (1) constructing radiators in space, (2) alternate high capacity heat pipe designs for radiator or other thermal control applications, and (3) a gimbaled or minimum-environment seeking radiator system to minimize radiator size and reduce sensitivity to thermal coating degradation from prolonged solar exposure. Other techniques for minimizing radiator size will be investigated including phase change thermal storage and high conductance radiator fins. An alternate to the baseline 'thermal bus' will be evaluated to demonstrate the merits

and limitations of competing heat transport designs. Finally, design options will be developed for efficient coupling and decoupling heat loads from the 'bus'.

W84-70214 **506-55-89**
Marshall Space Flight Center, Huntsville, Ala.
SPACE STATION - THERMAL MANAGEMENT (STORAGE AND REFRIGERATION)
James W. Owen 205-453-1173

The technical objectives of this activity include definition and demonstration of feasible phase change systems with regard to their application to active spacecraft thermal control. Specifically, in the area of energy storage, expendable and nonexpendable heat sink materials shall be evaluated for their ability to accommodate peak thermal loading conditions (orbital maximum or minimum). Refrigeration systems shall be evaluated for their ability to meet specialized low temperature thermal requirements (food and biological sample storage). In addition, various cycles shall be examined for the benefits of heat pump applications within radiator systems. The primary objective of these activities is to significantly reduce spacecraft radiator size and weight. Requirements shall be identified by the Government for integration of thermal storage and refrigeration systems into large spacecraft thermal control systems. Research and development contracts shall be initiated for thorough reviews of the technical status of these systems. Chosen concepts shall be developed for ground testing. Hardware developments shall be deliverable to the Government for integrated thermal control subsystem testing during FY-86.

Controls and Human Factors Research and Technology

W84-70215 **506-57-13**
Langley Research Center, Hampton, Va.
SPACECRAFT CONTROLS AND GUIDANCE
W. W. Anderson 804-865-3049
(506-53-43; 506-57-33)

A major activity in the future utilization of space will be the deployment or construction of large structures such as large-diameter antennas, manned space stations, or platforms. As a result of their size, these structures will necessarily be light-weight, loosely coupled, and flexible. Control systems for such missions must not only satisfy the requirements associated with spacecraft maneuvering and precision pointing, but also must provide active damping of flexible modes and effective shape control. The objectives of this program therefore, are to devise and employ advanced techniques for the analysis and synthesis of control systems for large space structures; design and evaluate control approaches for large space systems with particular emphasis on maneuvering, pointing, active damping, and figure control; generate and utilize techniques to quantify control system concepts effectiveness through laboratory and flight experiments, and evaluate robust and reliable integrated power/control systems. To accomplish these goals, advanced control modeling techniques, and on-line identification will be utilized in conjunction with dynamics models of such spacecraft configurations as a manned space station, Shuttle-attached sortie experiments, and large-diameter antennas. Control system implementations resulting from these efforts will be thoroughly evaluated to establish their performance capability and limitations. The analytical efforts will be complimented by ground validation, on such test articles as the Langley grid, and by flight experiments, such as in conjunction with a Shuttle-borne antenna experiment, to quantify the effectiveness of the various candidate control system designs.

W84-70216 **506-57-15**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTAL CONTROL THEORY AND ANALYTICAL TECHNIQUES
A. F. Tolivar 213-354-6215
(506-57-35)

The long range objectives of this RTOP are to develop fundamental theories, concepts, analysis, and laboratory verification methods for control technologies required for large dynamic structures. This RTOP encompasses the following four tasks: (1) distributed modeling and control - develop integrated structures/controls methodology for distributed system modeling and control analysis; (2) system identification - develop generic analysis and software tools for system identification of large space systems (LSS); (3) shape and dynamics identification system - develop an integrated module consisting of sensors, algorithms, computer hardware and software capable of performing the shape determination and dynamic system identification of LSS; (4) adaptive control - develop adaptive control approaches for future space systems with significant uncertainties in disturbances, system dynamics, and gross changes in system configuration.

W84-70217 **506-57-20**
National Aeronautics and Space Administration, Washington, D.C.
HUMAN FACTORS IN SPACE SYSTEMS
Melvin D. Montemerlo 202-755-3273
(505-34-40)

The objective of this RTOP is to conduct space operations research with particular emphasis on human capabilities assisted by various levels of automation. The research will be conducted by developing and testing a beam assembly teleoperator (BAT) for use in neutral buoyancy tests. Also tests will be conducted of closed cabin free flyers, head up displays for control of maneuvering units, simulation of telepresence technology, investigation of the human function in supervisory control and the investigation of expert systems for task assignment and housekeeping aboard a space station.

W84-70218 **506-57-21**
Ames Research Center, Moffett Field, Calif.
SPACE HUMAN FACTORS
H. P. Klein 415-965-5094
(199-10-52; 199-20-82; 505-35-11; 505-35-21; 505-35-31)

Future manned space systems may place the operators in a position of having more 'autonomy' and relying less on ground control. These missions will involve highly trained astronauts as well as other flight crew members and scientists. Maximum benefit from these future space systems will accrue only if the abilities of all crew members are fully exploited -- their performance maximized and their errors minimized. The objective of this RTOP is to develop an understanding of factors that are potential contributers to, or detractors from, individual and team operations in space. The program will initially focus on gaining the maximum benefit of past experience with space operation in addition to operations in other stressful environments which have similar characteristics to those encountered in space. Particular emphasis will be placed on identifying and extrapolating recent successful applications of human factors principles to operational problems, or example in aviation. Using the knowledge generated by such activity, development of reliability model(s) for human operators in these future space systems will be initiated.

W84-70219 **506-57-22**
Jet Propulsion Laboratory, Pasadena, Calif.
COOPERATIVE-DEXTEROUS TELEOPERATION FOR SPACE STATION
A. K. Bejczy 213-354-4568
(506-57-25; 506-54-65)

The general objective of this RTOP is to establish the technology readiness, by the end of FY-87, for engineering specification of a two-handed dexterous control system of a two-armed manipulator in a space station-type environment. The technology base will be developed on the optimal utilization of human manual control capabilities (both hands) in teleoperation in space through improved man-machine interface devices and techniques, including sensor and computer aided controls. This technology base covers: (1) coordinated control of two manipulators; and (2) control of dexterous end effectors. The FY-84 objectives are: (1) conduct task analysis of two-handed teleopera-

tion and coordinated control of two manipulators, including the study of analytic frames for performance modeling when feasible; (2) develop conceptual design of hand controllers suited for two-handed teleoperation; and (3) develop conceptual design of controllers for dexterous and effectors. The general approach is experimental. It creates new tools and techniques and their evaluation, closely related to generic application scenarios for space station. The development approach will consider both electromechanisms and data-driven automation aids, and will be coordinated with ongoing teleoperation related development efforts at JPL and other NASA centers. Cooperation with universities and other research centers will be established as appropriate.

W84-70220 **506-57-23**
Langley Research Center, Hampton, Va.
MANNED CONTROL OF REMOTE OPERATIONS
A. J. Meintel, Jr. 804-865-2489
(506-54-63; 506-64-23)

The objective of this plan is to study, synthesize, and optimize an efficient man-machine interface to remote systems and to apply advanced technology to achieve and enhance man's supervisory control of remote automated systems. The research will be conducted using a reconfigurable remote control station coupled to a software/laboratory-hardware simulation representing the remote system. Experimental studies will be carried out to determine human capabilities/limitations in teleoperation at increasing levels of automation of the remote task. The remote station will be reconfigured as required to evaluate controls, displays, and other system interface elements.

W84-70221 **506-57-25**
Jet Propulsion Laboratory, Pasadena, Calif.
TELEOPERATOR HUMAN INTERFACE TECHNOLOGY
A. K. Bejczy 213-354-4568
(506-54-65; 906-75-27)

The first general objective of this RTOP is to establish the technology readiness, by the end of the FY 87, for engineering specification of a two-handed dexterous control system of a two-armed manipulator in a space station type environment. The technology base will be developed on the optimal utilization of human manual control capabilities (both hands) in teleoperation in space through improved man-machine interface devices and techniques, including sensor and computer aided controls. This technology bases covers (1) coordinated control of two manipulators and (2) control of dexterous and effectors. The second general objective of this RTOP is to develop a data base and models for quantifying human performance in sensor- and computer-augmented information and control environment of teleoperator systems in order to advance the state-of-the-art currently represented by the Shuttle RMS baseline technology. This objective includes classification.

W84-70222 **506-57-26**
Goddard Space Flight Center, Greenbelt, Md.
GROUND CONTROL HUMAN FACTORS
W. F. Truszkowski 301-344-9261

The objective is to develop a technology base to better enable the allocation of command, control, analysis, planning, scheduling, and monitoring functions among men and automated computer systems. To accomplish this objective, guidelines for man/machine interfaces and interactions will be documented; a rapid prototyping environment for the study of human factors issues associated with man/machine interactions will be developed and tools for the analysis of automated ground control systems from a human factors point of view will be developed. Two major results will be the documentation by the Air Force of human factors guidelines and the development of a rapid prototyping environment for the study of human factors issues associated with automation.

W84-70223 **506-57-27**
Lyndon B. Johnson Space Center, Houston, Tex.
HUMAN FACTORS FOR CREW INTERFACES IN SPACE
J. L. Lewis 713-483-2845

The objective of this RTOP is to develop technologies which will increase the effectiveness of man-machine interactions in space. Specific tasks include development of guidelines for man-machine interfaces, development of models of human motion and strength and collection of data for these models, and development of specific productivity aides for use in extravehicular activity (EVA). The guidelines for man-machine interfaces will address the assignment of tasks to humans or to automation, the suitability of new technology for controls and displays in space, and other aspects of the interface such as habitability which are important for safe, efficient operations in space. The EVA tools under development include a glove end effector to increase the manual operations a crewmember can perform; a generic work station and restraint system; and a helmet-mounted heads-up display to increase the information available to an EVA crewmember. The models of human motion and strength will be integrated into the Graphics Analysis Facility at JSC to provide design engineers with quantitative information early in the design cycle. The multi-view laser-based anthropometric measurement system will be developed to provide much of the needed data for these models. Existing facilities that will be utilized include an avionics test bed, the Operator Station Design System and data base, and the Anthropometric Measurement Laboratory data base and equipment.

W84-70224 **506-57-28**
Ames Research Center, Moffett Field, Calif.
SPACE HUMAN FACTORS SPACE STATION AUGMENTATION
H. P. Klein 415-965-5094
(199-10-52; 199-20-82; 505-35-11; 505-31-21; 505-31-31)

Future manned space systems may place the operators in a position of having more 'autonomy' and relying less on ground control. These missions will involve highly trained astronauts as well as other flight crew members and scientists. Maximum benefit from these future space systems will accrue only if the abilities of all crew members are fully exploited -- their performance maximized and their errors minimized. The objective of this RTOP is to develop an understanding of factors that are potential contributers to, or detractors from, individual and team operations in space. The program will initially focus on gaining the maximum benefit of past experience with space operation in addition to operations in other stressful environments which have similar characteristics to those encountered in space. Particular emphasis will be placed on identifying and extrapolating recent successful applications of human factors principles to operational problems, for example in aviation. Using the knowledge generated by such activity, development of reliability model(s) for human operators in these future space systems will be initiated.

W84-70225 **506-57-29**
Marshall Space Flight Center, Huntsville, Ala.
TELEOPERATOR AND ORBITAL WORK STATION HUMAN FACTORS
W. O. Frost 205-453-1413

This RTOP includes three tasks relating to teleoperator and orbital work station human factors. Task 1, teleoperator human factors, defines a teleoperator human factors research plan. Data resulting from the tests/experiments/analyses defined by this plan characterize the effect of various technology options and development alternatives on the performance capabilities and limitations of the remotely located human operator as an lement of the teleoperator control system. This task also implements selected tests/experiments/analyses to provide teleoperator human factors data. Task 2, human function in space verification program definition, establishes and verifies guidelines for the allocation of tasks to humans vs. machines in the space environment. Task 3, orbital work station human factors, defines and evaluates human factor technologies required for orbital work station design, tools, and crew aids and develops requires guidelines and standards for effective and efficient man-in-the-loop operations and to enhance space station technology.

W84-70226 **506-57-33**
Langley Research Center, Hampton, Va.
ADVANCED CONTROLS AND GUIDANCE CONCEPTS
W. D. Mace 804-865-3745

The potential impact of advanced control mechanisms and digital design procedures can be expressed in terms of greatly expanded performance capability, orders of magnitude improvement in reliability and in terms of mission design adaptability and a broader range of mission objectives. This effort will identify and evaluate candidate system design concepts embodying the results from ongoing research in control law structures, in particular, drawing on recent advances from the aeronautics R&T base. These will contribute to analysis and maintenance of the structural integrity of the evolving spacecraft structure, to the stability and maneuverability of the system and to the reliability enhancement of the system as a whole. Existing and planned flight systems modeling and simulation facilities applicable to the orbiting space station will be extensively used to develop, evaluate, and test candidate system concepts.

W84-70227 **506-57-35**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CONCEPTS FOR GUIDANCE AND CONTROL
A. F. Tolivar 213-354-6215
(506-57-15)

The long range objectives of this RTOP are to develop design concepts, testing techniques, and components required for pointing, controlling, and guiding advanced spacecraft including large antennas, space stations and platforms, space transportation vehicles, and planetary spacecraft. This RTOP encompasses the following major tasks: (1) advanced control systems - develop and evaluate advanced control system concepts for space station, large RF antennas, segmented optics precision reflectors, and advanced precision pointing systems; (2) control technology flight/ground experiments - definition and design of technology experiments to validate concepts and techniques for control of large space systems (LSS); (3) advanced guidance and control components - develop a high performance integrated optics laser gyro, and an optical sensor for determining the static shape and vibrational motion of flexible spacecraft; (4) synergetic spaceflight systems GN&C - develop explicit and adaptive navigation and guidance technology for synergetic spaceflight systems to perform orbit modification and/or transfer using aerodynamic and propulsion forces.

W84-70228 **506-57-37**
Lyndon B. Johnson Space Center, Houston, Tex.
STS GUIDANCE, NAVIGATION AND CONTROL (GN&C) SYSTEM TECHNOLOGY DEVELOPMENT
K. J. Cox 713-483-4281

The objective is to develop and assess guidance, navigation, and control (GN and C) concepts and techniques to provide needed capabilities for the full utilization of current and future space transportation systems (STSs). Methodologies for the cost effective development and implementation of advanced GN and C capabilities will also be evaluated. To support the effective utilization of research resources, long-range GN and C technology planning will be performed. The GN and C technology needs will be addressed across interacting elements of STSs (e.g., space shuttle, OTV, TMS, and teleoperators). Studies will be directed toward technology developments which have the broadest application to these elements and which integrate the requirements and constraints associated with the interactions of these elements. Emphasis will be placed on the development of GN and C technologies supporting STS on-orbit operations and services. Three major tasks are included: (1) methodology for STS control envelope definition/expansion; (2) software development interactive with system development; and (3) long-range guidance, navigation, and control technology planning support.

W84-70229 **506-57-39**
Marshall Space Flight Center, Huntsville, Ala.
LARGE SPACE SYSTEMS - CONTROL AND GUIDANCE
H. J. Buchanan 205-453-4582
(506-62-49)

The objective of this research is to define, develop and demonstrate control techniques and devices required for future space platforms, stations, advanced earth orbiting spacecraft and advanced space transportation systems. Tasks specifically covered include: uprated fine guidance sensor - continued development of sensor technology for detection image motion in spaceborne telescopes; large space systems control technique, development and verification - the current laboratory test program will be expanded; modular control techniques - ongoing effort to develop a practical implementation with realistic sensor-effector requirements; linear and nonlinear modeling of flexible structures in an arbitrary topology for large space systems control - the present program AFBDAP will be expanded to include the ring topology of connected modules; autonomous momentum management for space station - techniques developed in FY-83 will be simulated in a fast, large angle simulation to determine performance; and control and sensing for autonomous rendezvous and docking - The previously developed techniques will be improved and demonstrated utilizing a high fidelity in-house test. Tasks 3 and 4 above were grouped under the task modular control in FY-83, but they have been separated in FY-84 to improve the reporting of accomplishments.

Space Data and Communications Research and Technology

W84-70230 **506-58-10**
National Aeronautics and Space Administration, Washington, D.C.
ARCHIVAL MASS MEMORY
Kenneth R. Wallgren 202-755-8501
(506-58-09)

The objective is to develop an on-line archival mass memory device capable of storing and retrieving up to 10 to the 13th power bits of information at rates up to 50M bits/second. Laser/optical disk technology will be employed in concert with a mechanical manipulator to retrieve and mount individual disks.

W84-70231 **506-58-11**
Ames Research Center, Moffett Field, Calif.
FUTURE DATA SYSTEMS CONCEPTS
T. L. Grant 415-965-6526
(506-54-61)

The objective is to advance the state-of-the-art in data network technology through analysis of general concepts and the implementation of software simulation to define, develop and evaluate detailed concepts, including promising coding designs. The emphasis in this technology development is on reduced system complexity for data networks and on increased reliability while providing the flexibility to expand data capacity as processing requirements increase. A network simulation capability is planned via software models using the Ames Research Center computational facilities. It will provide a testing tool for developing and evaluating detailed conceptual designs as well as augmenting the analysis of general network concepts. After the system requirements and evaluation criteria are defined, various data networks will be modeled in coordination with other Centers. The software simulations will also be used to evaluate coding designs which will be developed for added capacity and error-free data distribution.

W84-70232 **506-58-13**
Langley Research Center, Hampton, Va.
DATA SYSTEMS RESEARCH AND TECHNOLOGY
N. D. Murray 804-865-3535

The primary objective of the Data Systems Research and Technology activity is to investigate, research, and develop key technologies for: (1) real-time very high-speed data and information

processing onboard spacecraft; (2) high density, high-speed data storage for onboard spacecraft; and (3) network architectures and optical nodes to attain high performance processing, communications and distribution of information onboard a space station. To address the real-time processing, the information adaptive system (IAS) has been developed to process multispectral images, and the current effort is oriented to maintaining the IAS. The main thrust of the onboard data storage activity is the development and demonstration of an advanced magnetic bubble memory module. The network activity is oriented to the development and demonstration of an adaptive node network architecture, and of an optical adaptive node.

W84-70233 **506-58-14**
Jet Propulsion Laboratory, Pasadena, Calif.
PROTOTYPE SOFTWARE ACQUISITION MANAGEMENT PLAN
E. D. Callender 213-354-5365
(506-58-05; 506-54-55)

The objective of this RTOP is to produce a draft of a prototype Software Management Acquisition Plan, have this draft reviewed by interested groups within the Space Station community, and then produce a final draft for submittal to the Space Station Project. The development of the prototype Software Management Acquisition Plan is essentially one of defining requirements for information, identifying and evaluating existing and purported information sources, and classifying the resulting information base. As such, the project will involve an information gathering and disseminating operation, leading to the informed definition of a series of time dependent tasks involving the effective and efficient management of Space Station Software Systems acquisition. The data gathering activities for the development of SWAMP will occur in two basic modes. The first mode is supported by the use of electronic mail (Telemail, etc.). There will be a frequent exchange of ideas, messages, memos, and drafts of repots via electronic mail. The second mode will consist of quarterly meetings of all active project members which will allow more effective interchange of ideas than is possible with electronic mail.

W84-70234 **506-58-15**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA SYSTEMS RESEARCH AND TECHNOLOGY
T. Duxbury 213-354-4889
(506-54-55)

This RTOP is comprised of an integrated set of tasks which respond directly to program and specific objectives (PASO) targets. Overall coordination of this RTOP is the responsibility of T.C. Duxbury with the responsibility of each task residing with the task manager. The objectives of this RTOP are to develop and demonstrate the systems technology and techniques which enable more efficient and effective transfer of useful data from the sensor to the user, and facilitate sensor control by a distributed body of users at substantially reduced cost and complexity, with emphasis directed toward the requirements of manned space station missions such as fault tolerance and subsystem autonomy. The approach to meeting these objectives includes activities in basic research, spacecraft and space station technologies. Basic research will extend the theoretical basis for modeling and translating data structures between heterogeneous data bases and will advance optical transmission and processing technology. Spacecraft efforts will develop very high speed processing of on-board synthetic aperture radar imaging by ground-based facilities. Additionally, space station efforts will concentrate on developing advanced data system architectures which are readily adaptable in flight to changing mission requirements and which provide automatic detection and recovery from component failure in flight. This architecture will provide relative insensitivity to evolving device technologies and localize the effects of changes within subsystems to reduce the costs and complexities of system level integration, testing and verification.

W84-70235 **506-58-16**
Goddard Space Flight Center, Greenbelt, Md.
DATA SYSTEMS RESEARCH AND TECHNOLOGY
R. W. Nelson 301-344-7809

The Data Systems Research and Technology Program develops and demonstrates the systems technology which will substantially increase the capability of onboard and ground-based data systems in response to requirements for future NASA missions such as the space station. Elements of the ongoing program include developing a high-speed optical data bus with flight qualified fiber optic components, determining the feasibility of use of optical disk recorders in spacecraft, advancing the state of the art in onboard smart sensor image data processing and storage with gallium arsenide integrated circuit technology, extending and evaluating the high-volume data processing capabilities of the massively parallel processor, developing and evaluating cataloging/retrieval capability for data base management and defining methodologies for the assessment of alternative data system architectures.

W84-70236 **506-58-17**
Lyndon B. Johnson Space Center, Houston, Tex.
DEVELOPMENT OF A MAGNETIC BUBBLE MEMORY SYSTEM FOR SPACE VEHICLES
E. Dalke 713-483-2851

The continuing RTOP effort will evaluate the compatibility of magnetic bubble memory component technology for space vehicle mass memory systems applications which are presently implemented with electro-mechanical magnetic tape units. The effort will investigate and resolve system development issues related to multifunction application, systems interfacing, performance capabilities, and space environment compatibility. The activity will utilize the shuttle/orbiter magnetic tape mass memory to establish system requirements which include a one-for-one replacement that is totally transparent to the orbiter software system as well as the electrical and mechanical interfaces. The development effort will be accomplished with the services of a selected system supplier who will deliver a single flight type package for orbiter integration and functional verification. The effort will integrate previous and continuing LaRC magnetic bubble devices technology efforts to insure compatibility with anticipated evolution.

W84-70237 **506-58-19**
Marshall Space Flight Center, Huntsville, Ala.
DATA SYSTEMS TECHNOLOGY PROGRAM (DSTP) DATA BASE MANAGEMENT SYSTEM AND MASS MEMORY ASSEMBLY (DBMS/MMA)
D. T. Thomas 205-453-0677

The objective is to develop a ground data base management and archival system to demonstrate high-rate data ingest, automatic cataloging, and real-time archiving of large volumes of packetized sensor data. The catalog, sensor data, and other on-line space information would be available to local and remote users in near real-time. High rate ingest, up to 50M bits/second, is achieved by the use of a fiber optic data bus driver by laser diodes and an architecture that bypasses conventional computer channels. The on-line archival system is an optical disk recorder/reader capable of recording and reading digital data at 50M bits/second and storing 8 x 10 to the 10th power bits per fourteen inch disk with a total volume of 10 to the 13th power bits. Recording at high density is archieved by the use of a laser as the energy source.

W84-70238 **506-58-22**
Lewis Research Center, Cleveland, Ohio.
SATELLITE COMMUNICATIONS RESEARCH AND TECHNOLOGY
R. E. Alexovich 216-433-6689
(650-60-21; 650-60-22)

The objective is to provide through research, design and experimental tests the components, subsystems and enabling technology required to support NASA satellite communications systems. To achieve this objective, advanced research and development programs will be conducted to identify, produce and demonstrate critical components, techniques and subsystems

required for complete communications systems. Principal emphasis will be directed toward spacecraft microwave electron beam amplifiers with increased power output, linearity, efficiency, high frequency capability and long life; multi-frequency, multi-beam antennas providing increased frequency reuse; and solid state materials and component technology for high frequency spacecraft applications, such as switching, power amplification and beam forming.

W84-70239 **506-58-23**
Langley Research Center, Hampton, Va.
MULTIPLE BEAM ANTENNA TECHNOLOGY DEVELOPMENT PROGRAM FOR LARGE APERTURE DEPLOYABLE REFLECTOR
Thomas G. Campbell 804-865-3631

The overall objective of this RTOP is to specifically address the development of multiple beam antenna technology and analysis methods that are critically related to the technology development activities of the deployable reflector concepts presently funded by OAST. The development of multiple beam feed technology that is specifically related to the large aperture antenna development will eventually provide NASA the capability of predicting the total antenna system performance characteristics for a wide range of mission applications (communication, radiometer, and radio astronomy). Primarily, this activity shall provide a top-level basis for determining the effectiveness of large off-set reflector systems (with up to 200 beams) that are presently being considered for communications and radiometer near-term and far-term missions. Tasks to be accomplished include: the development of the feed requirements for communication and radiometer missions for multiple beams and multiple apertures; antenna configuration design for the point design; multiple beam antenna feed point design; and derivation of secondary illumination and multiple beam contour for co-polar and cross-polar plots, spherical near-field testing using subscale models.

W84-70240 **506-58-24**
Lyndon B. Johnson Space Center, Houston, Tex.
AUGMENTATION - MANNED SPACE STATION COMMUNICATION AND TRACKING TECHNOLOGY (SPHERICAL COMMUNICATIONS)
K. Krishen 713-483-5518

The objective is to develop microwave and optical communications and tracking systems technology for the space station aimed at: significantly reducing space station operational constraints and the risk/cost of operations; providing lower cost alternatives to present technology; and developing technology needed for cost effective modular growth of the space station. This augmentation is specifically directed toward the space station operational problem of providing communications services to a wide range of vehicles and EVA personnel operating in the proximity of the space station such that antenna(s) patterns must provide spherical coverage. Technical emphasis is directed toward phased array antennas providing functional flexibility in programmatic environment of changing requirements.

W84-70241 **506-58-25**
Jet Propulsion Laboratory, Pasadena, Calif.
DEEP SPACE AND ADVANCED COMSAT COMMUNICATIONS TECHNOLOGY
J. F. Boreham 213-354-4107
(650-60-15)

This RTOP represents two major technology areas in the space communications development effort, namely: (1) deep space communications technology (DSCT) and (2) advanced communications satellite technology (ACST). The general objectives of this RTOP are to develop microwave communications system component technology to support space-to-earth data distribution/transfer requirements of NASA's future deep space missions and ACS type missions to insure the continued U.S. preeminence in these satellite communication areas. The objectives in the DSCT area center around the 10 to 20 watt X-band solid state power amplifier (XSSPA) development and the development of new technology for the X-band transponder; while in the ACST area they center around large multibeam antenna technology development. More specifically during the first half of FY-84 key components of the 20 watt stand-alone XSSPA using high efficiency 4 watt GaAs FETs will be completed and by the end of the third quarter the full 20 watt XSSPA will be completed and evaluated. The major X-band transponder development tasks supported under this RTOP include (a) dielectric resonator stabilized, phase locked, high order multipliers and (b) a microprocessor controlled digital phase lock loop both of which will be incorporated in a verification breadboard demonstration by the end of FY-84. In the ACS area, more specific objectives for FY-84 and FY-85 include: (1) continue the development of software necessary for designing and predicting RF performance of advanced antenna systems; (2) continue the development of antennas and feeds for multibeam and radiometer applications; and (3) develop ground and in-flight RF measurement techniques for large spaceborne antennas.

W84-70242 **506-58-26**
Goddard Space Flight Center, Greenbelt, Md.
LASER/MICROWAVE COMMUNICATIONS
J. S. Chitwood 301-344-6375
(506-62-26; 506-58-22; 650-60-26)

The objective of this program is to develop and demonstrate advanced transmitter and receiver technology and data transfer techniques required for high performmance microwave/millimeterwave and optical communication systems. In the area of RF communications, microwave and millimeterwave spacecraft components, techniques, and circuits will be developed to support flight programs characterized by high data rates, simultaneous multiple links, and reliable long life operation. Emphasis will be placed on millimeterwave technology, especialy at 60 GHz, for intersatellite communication applications. The emphasis of the laser communication effort is on the development of high performance laser transmitter modules which are suitable for use in high data rate optical communication systems. Research into receiver technology, such as advanced solid state detectors and optically coherent communications, will be performed.

W84-70243 **506-58-27**
Lyndon B. Johnson Space Center, Houston, Tex.
MANNED SPACE STATION COMMUNICATION AND TRACKING TECHNOLOGY
K. Krishen 713-483-5518

The objective is to develop microwave and optical communicatons and tracking systems technology for the space station aimed at: (1) significantly reducing space station operational constraints and the risk/cost of operations; (2) providing lower cost alternatives to present technology; and (3) developing technology needed for cost-effective modular growth of the space station. The breadboard (partially fabricated in FY-83) for the optical infrared system which will provide secure very wide bandwidth for intra-vehicular and proximity communications, will be completed and tested in the JSC Test Laboratory. The breadboard for the multiple steered beam antenna, designed in FY-83, will be fabricated and tested. Other task areas will include: developing accurate ranging and tracking systems, and space station signal design computer simulations which will incorporate high frequency hopping, time division spread spectrum, coding schemes for improved security, and adaptive agile carrier techniques.

W84-70244 **506-58-28**
Langley Research Center, Hampton, Va.
SPACE STATION ANTENNA TECHNOLOGY
M. C. Gilreath 804-865-3631
(506-62-53)

The objectives of this program are to develop generic antenna designs suitable for providing the required pattern coverage about the space station for communications and tracking systems operating from UHF into the millimeter frequency range and to develop the analytical techniques required to accurately predict the performance of these antenna systems including the effects of the complex space station structures. Scale models of generic

antenna concepts for generating source fields in sector/spherical coverage studies will be developed. Three dimensional analytical models of complex space station structures will be developed, deficiencies in SOA antenna performance prediction techniques for space station applications will be identified and extensions will be made to these techniques to satisfy space station prediction requirements. An experimental modeling program will be utilized for analysis verification.

Chemical Propulsion Research and Technology

W84-70245 **506-60-10**
National Aeronautics and Space Administration, Washington, D.C.
CHEMICAL PROPULSION R AND T INTERAGENCY SUPPORT
F. Stephenson 202-755-2490

The primary objective of this activity is to maintain a continuous up-to-date information gathering capability on the nation's total chemical propulsion technology efforts as an aid in planning and implementing the NASA program. In addition, joint interagency tasks are undertaken when appropriate, such as publishing handbooks, manuals or computer models, that will be beneficial to the propulsion community as well as other potential users. The approach is to share support of the Chemical Propulsion Information Agency (CPIA), which supplies information gathering and dissemination services, with the DOD agencies through the Joint Army, Navy, NASA, Air Force (JANNAF) Interagency Propulsion Committee. For special interagency tasks, funding is transferred to the agency designated as responsible for the procurement action and contract monitoring.

W84-70246 **506-60-12**
Lewis Research Center, Cleveland, Ohio.
EARTH-TO-ORBIT PROPULSION LIFE AND PERFORMANCE TECHNOLOGY
G. M. Reck 216-433-4000
(506-60-19)

The driver for future earth-to-orbit launch vehicles will be advanced high pressure liquid rocket engines used for the main propulsion system. These propulsion systems will have to provide the lowest possible life cycle costs while meeting the needs of all potential users. The objective of this program is to extend the existing technological base established by the space shuttle main engine (SSME) and older hydrocarbon fueled engines to provide the knowledge for reusable, long life, serviceable, high performance engine systems using either hydrogen-oxygen or hydrocarbon-oxygen. This effort will concentrate on thrust chamber cooling and life enhanement, critical turbomachinery components including bearings, seals, turbine blades, rotordynamics, diagnostic techniques, and improved materials. This work will be accomplished through studies, analytical models, fundamental subscale testing, and correlation of all inputs.

W84-70247 **506-60-19**
Marshall Space Flight Center, Huntsville, Ala.
REUSABLE HIGH PRESSURE MAIN ENGINE TECHNOLOGY
S. F. Morea 205-453-3908
(506-60-12)

Advanced reusable booster engines required for Earth-to-orbit application are being investigated. The overall objectives are to: (1) advance the technology base for future oxygen/hydrocarbon and oxygen/hydrogen booster engines and (2) advanced the technology in support of future space shuttle main engine (SSME) improvements. Technology for advanced high pressure oxygen/hydrocarbon rocket engines for booster application is being pursued and includes single-fuel, dual-fuel and dual-throat concepts. These activities include engine power cycle synthesis, parametric data generation, component performance prediction and evaluation, and combustor and turbine cooling investigation. These efforts include data screening, analysis, computer modeling, hardware design and fabrication, data evaluation and test. As the SSME program approaches operational status, specific technology activities are required for resolution of persistent trouble areas and for improving life and reducing operating cost. The effort necessary to accomplish these objectives is defined in the Advanced Research and Technology Plan. The areas of investigation are basic in nature and are supportive of future SSME uprating and definition of advanced lox/hydrogen engines.

W84-70248 **506-60-22**
Lewis Research Center, Cleveland, Ohio.
ADVANCED ON-BOARD SPACE STATION AUXILIARY PROPULSION
G. M. Reck 216-433-4000

The objective of this effort is to provide a technology base for a small gaseous hydrogen-oxygen propulsion system for application to the auxiliary propulsion system for space station. The accomplishment of this objective would provide options for the auxiliary propulsion system that could significantly reduce propellant resupply requirements and mission life cycle costs. The system that will be investigated is one that would draw propellants from a common space station hydrogen-oxygen storage system which is onboard to service OTVs, life support, environmental control, and fuel cell power systems. These low pressure propellants which could be boil-off gases would be raised in pressure, conditioned, and stored in accumulators for subsequent feed to the thrusters. Emphasis of the work will be on: small high performance combustors, igniters, propellant conditioners, and engine health monitoring and diagnostics.

W84-70249 **506-60-42**
Lewis Research Center, Cleveland, Ohio.
VARIABLE THRUST ORBITAL TRANSFER PROPULSION
G. M. Reck 216-433-4000
(506-60-49)

The objective is to provide technology for improving performance, life and reusability of future highly versatile liquid chemical rocket engines in order to greatly extend mission capability and flexibility in performing orbital operations reliably and at reduced operating costs. The propulsion systems that will be investigated include a highly versatile, space baseable, throttlable, reusable, and maintainable high thrust rocket engine. Emphasis of the work will be on: combustion, cooling and heat transfer; performance enhancements; long life bearings and seals; lightweight reusable components; small high performance combustors and pumps; high expansion area nozzles.

W84-70250 **506-60-49**
Marshall Space Flight Center, Huntsville, Ala.
OTV PROPULSION AND PLUME CHARACTERIZATION
R. J. Richmond 205-453-3710
(506-60-42)

Advanced reusable oxygen/hydrogen engines required for future orbit-to-orbit vehicles are being investigated. The activities described include advanced engine power cycle analysis and synthesis, technology identification and acquisition, component and system performance prediction model improvement, and high area ratio nozzle concept definition. These efforts include computer modeling, data screening, analysis, hardware fabrication, test, and data evaluation. A high altitude plume flow field computer code is being developed concurrently with a plume impingement code for use as a standard throughout NASA, DOD and industry. The plume impingement code will use the high altitude plume code as input and will be updated and improved based on flight data to be obtained on future shuttle payloads. The acquisition of these data on future shuttle missions is being planned by the Space Technology Interdependency Group (STIG).

Spacecraft Systems Research and Technology

W84-70251 **506-62-21**
Ames Research Center, Moffett Field, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTOR
B. L. Swenson 415-965-5705
(159-41-01)

The objective of this RTOP is to carry out systems studies, analyses, and trades and simulations, both in-house and under contract to support NASA space science objectives in astrophysics and planetary probe/penetrator missions. In particular, current emphasis will be placed on the refinement and development of concepts for a large deployable reflector (LDR) in space. The LDR will be a free-flyer with an aperture greater than 10 m to support astrophysical and astronomical investigations in the infrared and submillimeter wavelength regimes. The effort supported by this RTOP is aimed at providing the preliminary systems analysis and programmatic planning preparatory to a major LDR technology initiative by OAST, planned to be started in FY-86. The effort involves a major contracted study, jointly supported by OSSA, to examine many overall system and subsystem issues; define a point-design concept(s); assess the readiness of technology to support the implementation of LDR by 1990; and develop a technology development plan to remedy major deficiencies to allow implementation of LDR with confidence and minimum risk. Concurrent with this study, complementary efforts will be supported at other Centers where particular expertise resides.

W84-70252 **506-62-22**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATION SATELLITE SPACECRAFT BUS TECHNOLOGY
E. E. Kempke 216-433-4000

The objective of this RTOP is to identify, assess, and prioritize high-leverage enabling and enhancing technologies for communication satellite spacecraft buses of the mid 1990s; and to formulate a long-range technology development plan which defines enabling technology appropriate for development by NASA. The approach provides for a LeRC in-house effort to establish advanced spacecraft bus requirements, identify concepts and technologies to meet these requirements and conduct system and discipline trade studies in order to assess/evaluate potential payoff of identified technologies. Contracted studies will be conducted to verify and augment in-house studies. The results from the above efforts and recommendation of industry will be used to develop a long range technology development plan. A forum for a continuing government/industry dialog on enabling technologies will be established.

W84-70253 **506-62-23**
Langley Research Center, Hampton, Va.
ADVANCED LARGE SPACECRAFT SYSTEMS ANALYSIS
L. S. Keafer 804-865-3666
(506-62-43; 506-64-13)

The long-range technical objective is to support development of advanced spacecraft systems for NASA scientific missions and space operations, DOD missions, and commercial ventures in space. The work includes: (1) requirements definitions and conceptual designs of the missions, the associated spacecraft systems and technology-validating experiments; (2) analyses and comparisons of the competing system concepts; (3) analyses and assessments of technology advances needed to implement the system concepts; (4) selected hardware testing; and (5) building of a versatile computer-aided design and analysis capability for advanced spacecraft systems. Priority tasks for FY-84 are: (1) analyses support for Phase A of a Large Antenna Flight Experiment to be flown on shuttle in the late 1980's and for the definition of other proposed STEP experiments; (2) analysis and selected testing of the kinetics/kinematics of deployment of box-truss and other large antenna structural configurations; and (3) controls-dynamics study and development of first-order controls synthesization and analysis techniques. In-house expertise and analysis tools will be used for most of the tasks. Contractual support will focus primarily on the kinetics/kinematics of deployment area, which includes hardware testing. The computer-aided design and analysis capability will be augmented by in-house developments and up-dates and by exchanges of software with the aerospace industry.

W84-70254 **506-62-25**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY SPACECRAFT SYSTEMS TECHNOLOGY
Kerry T. Nock 213-354-2153

The specific objective is to provide systems analysis of future planned high priority planetary missions to develop generic system-level technology and to define discipline goals and requirements. The approach to be taken is to: (1) develop a planetary mission model based upon delibrations with OSSA; (2) quantify the system-level and discipline technology requirements of the missions in the model; (3) evaluate the technology requirements as to effect on mission performance and technology readinesses; (4) prioritize technology requirements with respect to need, performance, mission priority and other non-performance issues; (5) generate technology development plans for several high priority technologies; and (6) implementation of long range program for technology development.

W84-70255 **506-62-26**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED EARTH ORBITAL SPACECRAFT SYSTEMS TECHNOLOGY
P. A. Studer 301-344-5229

The objective of this program is to identify, coordinate, and organize technological advances which will achieve and enhance future Earth orbital mission objectives. The needs of planned and projected missions will be reviewed and compared on a time-line basis with the development cycles of emerging technologies with identifiable potential and applicability to space operations. Cross-fertilization of technological skills and techniques from areas of subsystem expertise will be promoted. Technological advances within and outside the Agency will be tracked and transmitted between subsystem disciplines. Included is the definition and progressive updating of a system technology Development plan. An interdisciplinary total spacecraft systems approach to development tasks is the goal. Working basically from future mission requirements, vital technology needs areas will be identified, the state and pace of their development charted, and results directed to parallel subsystem developments and eventually flight programs in their earliest phases. This approach will avoid duplication and more efficiently utilize resources by transfer of developments and techniques between on-going subsystem specialists and through the communication of accomplishments from research centers to flight system designers. The impact of upcoming technology advances on future mission planning will be assessed and communicated to minimize the lag in systems development and deployment.

W84-70256 **506-62-29**
Marshall Space Flight Center, Huntsville, Ala.
ASTRONOMICAL INTERFEROMETRIC SYSTEMS TECHNOLOGY REQUIREMENTS
Max E. Nein 205-453-3430
(506-53-49; 506-57-39)

It is expected that the Space Telescope (ST) will dominate astronomical observations throughout the 1990's. However, astrophysical observations with ST will certainly give rise to new questions which will require increased spatial resolution and photon gathering capability for astronomical instruments of the late 1990's and beyond. Prior studies have shown that the traditional evolution of space telescopes to larger apertures has reached a technology barrier. Introduction of interferometric systems will increase resolution by orders of magnitude. However, implementing large interferometric systems at short wavelengths places extreme requirements on materials and systems technology and operation with regard to development of lightweight structures of extreme

dimensional stability, orbital operations, assembly and alignment, optical beam combining and data reconstruction. Prior experience with large astronomical systems has shown that concept selection is very dependent on the maturity of key technologies. It is, therefore, the objective of this RTOP to conduct a multiyear technology activity evaluating advanced interferometric concepts and identifying generic technology requirements and technology drivers. With the assistance of scientific consultants, the study will maintain a focus towards realistic user requirements.

W84-70257 **506-62-43**
Langley Research Center, Hampton, Va.
SPACE TECHNOLOGY EXPERIMENTS-DEVELOPMENT OF THE HOOP/COLUMN DEPLOYABLE ANTENNA
Thomas G. Campbell 804-865-3631
(506-62-53)

The overall objective of the RTOP is to specifically address the technology development of large deployable reflector technology through the development of the hoop/column antenna concept. The technology development activities will reach a significant milestone as the 15-meter model of the hoop/column concept will be completed in FY-84. This model will then serve as a structural kinematics model and provide verification of the design in terms of deployment kinematics, deployment, reliability, failure modes investigation, surface interaction, manufacturing tolerances and scaling. This model will also permit the comparison of a manufactured surface shape with the prebuilt analytical projection of that surface shape. In addition, the 15-M model will be used in a RF test in a planar near field facility.

W84-70258 **506-62-45**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED SPACE STRUCTURES ANTENNA TECHNOLOGY DEVELOPMENT
Robert E. Freeland 213-354-3540

The long range objectives of this RTOP are to (1) develop the ofset wrap-rib deployable antenna concept to the point of flight technology readiness for a class of potential applications, and (2) develop the analytical capability at JPL for the prediction of antenna performance. The technical approach is to (1) establish the practical limit of performance for the basic wrap-rib deployable antenna concept, (2) support NASA and DOD sponsored system studies based on applications of the offset wrap-rib antenna concept, (3) demonstrate and evaluate technology maturity with large size proof-of-concept hardware models that will validate design, manufacturing, assembly and functional capability of the concept, (4) perform antenna component and assembly model testing to validate analytical models and verify mechanical performance equirements, (5) develop the analytical capability to quickly and cost effectively predict antenna on-orbit static, dynamic and thermal behavior and its effect on RF performance, (6) develop technology requirements for a flight experiment that addresses the limitations and builds on results of the ground-based technology program and (7) develop a cost and schedule data base for full size antenna hardware.

W84-70259 **506-62-49**
Marshall Space Flight Center, Huntsville, Ala.
SOLAR ARRAY FLIGHT EXPERIMENT (SAFE)
Henry C. Hill 205-453-3423
(506-55-49)

The first objective of this RTOP is to provide an overall demonstration of the availability of advanced solar array technology by flight testing the SAFE as an experiment on shuttle. The approach consists of four basic steps: (1) define SAFE requirements, criteria and conceptual design (completed FY-77); (2) perform a detailed design, build, and test the flight array experiment; (3) install and fly the solar array experiment on shuttle; and (4) evaluate flight results after return to Earth. The approach consists of developing/flight qualifying/flight verifying remote sensing and recording systems for measuring Solar Array Experiment X and Y coordinate motions obtained from controlled orbiter VCS firings; and correlating flight data with analytical/ground test data to define orbit peculiar characteristics.

Transportation Systems Research and Technology

W84-70260 **506-63-23**
Langley Research Center, Hampton, Va.
TECHNOLOGY REQUIREMENTS FOR ADVANCED SPACE TRANSPORTATION SYSTEMS
J. P. Arrington 804-865-3911
(506-51-13)

The objective of this RTOP is to identify, justify, and prioritize high-leverage enabling and enhancing technologies for both current evolutionary and future new space transportation systems. This includes the projection of future transportation needs, the characterization of potential future mission and economic capabilities based on the design of advanced concepts, and the assessment of technology impacts on desired transportation attributes. The approach focuses on the total transportation system, including both Earth-to-orbit and orbital transfer vehicles, which operate primarily within the geosynchronous sphere. The intent is to build on the space shuttle technologies which enhance the current Space Transportation System (STS) and enable new systems which have significant cost and/or capability advantages as required be a second generation STS. Technology areas of particular interest include: composite and thermal protection materials, propulsion systems, structural design, aerothermodynamics, design integration, advanced flight control, and automated operations. This activity will be pursued through in-house system studies, selected in-house assessments, contracted systems assessments, and intercenter reviews. This RTOP also supports the continuing enhancement of in-house computer-aided design systems that provide the ability to assess alternative approaches for transportation systems through conceptual design studies.

W84-70261 **506-63-29**
Marshall Space Flight Center, Huntsville, Ala.
CONCEPTUAL CHARACTERIZATION AND TECHNOLOGY ASSESSMENT
R. E. Austin 205-453-2813
(506-63-19)

Aeroassist is a technological capability that has a potential ranging from significant mission enhancement (orbit transfer vehicle-OTV) to mission enabling (some planetary orbiters and DOD). Prior studies have shown that significant performance benefits can be realized by using an aerodynamically assisted insertion into an orbit (planetary and low Earth). This maneuver substantially reduces the mission propellant requirements via a reduction in the deltaV required for an all propulsive braking maneuver. Studies have assessed aeroassisted system concepts ranging from simple devices to high L/E winged systems. While aeroassisted concepts show performance advantages over all propulsive concepts; launch capabilities, basing techniques (ground or space), and mission requirements (OTV, DOD, planetary, etc.) have a strong influence on aeroassisted system concept selection. It is the objective of this RTOP to conduct a multi-year aeroassisted system technology study that will evaluate generic aeroassisted OTV system concepts leading to a selection of the most promising approach for initial aeroassisted OTV application. This study then leads to a focused OTV technology readiness program (Phase I) for the initial system that has a target completion in FY-87. A follow-on aeroassisted technology development activity (Phase II) is envisioned that would permit an upgrading to a manned OTV capability. Transportation systems technology will be evaluated to focus and analyze technology requirements for advanced transportation systems, Earth-to-orbit launch vehicles, orbit-to-orbit vehicles, etc. The initial phase of the transportation systems technology assessment will extend over a multi-year period.

W84-70262 **506-63-31**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX (ORBITER EXPERIMENTS) PROJECT SUPPORT
J. D. Harris 713-483-5814

The OEX Program was initiated jointly by JSC and OAST to utilize the space shuttle as a research vehicle. The program objective is to collect data in the technology disciplines that will augment the research and technology base for future spacecraft design. Flight data relative to these disciplines will be collected by utilizing the currently planned TFI/MADS configuration, by modifications and/or augmentations to the OFT baseline instrumentation and by development of unique experiments compatible with the operational capabilities for flight on the orbiter. Studies will be conducted to determine the optimum method of utilizing the shuttle system to conduct research and technology. These studies will be augmented by investigations to develop experimental programs that would obtain research and technology data in flight regimes applicable to advanced space transpotation systems. The primary goal of these studies is more efficient utilization of the STS capabilities to obtain data required to advance the current state of spacecraft technology. This RTOP includes the effort associated with overall project management, project support, experiment development initiation, experiment compatibility assessments, experiment integration activities and integration hardware development initiation. The experiment development efforts are the subject of additional RTOP's from the appropriate NASA Centers.

W84-70263 **506-63-32**
Langley Research Center, Hampton, Va.
SHUTTLE ENTRY AIR DATA SYSTEM (SEADS)
P. M. Siemers 804-865-3984
(506-51-13)

The objective is to extend the knowledge of aerodynamics, aerothermodynamics, and basic fluid mechanics into flow regimes previously inaccessible to the investigator through extraction of flight data during routine operation of the shuttle orbiter. This knowledge will be applied to verify and increase the reliability of sophisticated computational prediction codes, to develop procedures to extrapolate wind-tunnel data to flight conditions, to improve the performance and operational capability of the STS, and to prove a data base for studies of future aeronautical and aerospace vehicles. The design, development, calibration, and demonstration of the flush orifice shuttle Entry Air Data System will be accomplished through in-house (LaRC) analysis and test programs, and contracted studies. A retrofitted instrumented nose cap, incorporating the flush orifice Shuttle Entry Air Data System, will obtain flight data which, when reduced, will produce the required air data parameters for each orbiter flight. These data, in conjunction with inertial data, development flight instrumentation data, and data obtained by specialized instrumentation packages, will be utilized to verify aerodynamics and aerothermodynamics performance as well as resolve many basic fluid mechanic questions.

W84-70264 **506-63-34**
Langley Research Center, Hampton, Va.
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING (SILTS)
E. V. Zoby 804-865-2707

The objective is to extend the knowledge of the basic aerothermodynamics of leeside flow fields and heat transfer on large lifting vehicles into flow regimes which are inaccessible to investigations in ground facilities through sensing of leeside surface temperatures during shuttle orbiter entry with an infrared scanner. These data will permit development of improved leeside flow-field and heat-transfer prediction techniques which are required to reduce considerably the weight and cost of thermal protection systems on the leeside of future space vehicles. This experiment utilizes a highly developed infrared scanner and recording system which was qualified for the severe ascent environment in a development program at the Langley Research Center. The instrumentation and supporting equipment was installed in a Langley manufactured engineering test model and tested at the Langley Research Center; the flight structural pod, exclusive of the dome, was manufactured by the shuttle orbiter contractor. The SILTS experiment will be flown on a number of orbiter flights.

W84-70265 **506-63-36**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMIC, ACOUSTIC, AND THERMAL ENVIRONMENTS (DATE) EXPERIMENT (TRANSPORTATION TECHNOLOGY VERIFICATION–OEX PROGRAM)
W. F. Bangs 301-344-7669
(323-52-42)

The DATE Experiment is one of the OAST OEX (Orbiter Experiments) group of STS flight experiments. The DATE program has two objectives. The first is the development and validation of advanced technology for prediction of dynamic, acoustic, and thermal environments and associated payload responses in cargo areas of large reusable space vehicles. The second is providing data for immediate application in payload design and verification activities. DATE plans to use environmental data from approximately 15 early shuttle flights in support of these technology efforts. The early shuttle flights represent an unusual opportunity to obtain the particular types and quantities of data that are suitable for implementing the DATE Program, but would not be included in the environmental data normally acquired for operational purposes. Repeated measurements are necessary to account for payload, orbiter, and launch site variations. By end of FY-83 DATE will have accomplished its partial objectives with flight experimental data obtained and reports generated from flights STS-1 through STS-5 and an OASIS system ready integration. In FY-84, the objectives will be to continue integration support of calibrated qualified instrumentation, data analysis, and generation of flight reports for flights of opportunity.

W84-70266 **506-63-37**
Langley Research Center, Hampton, Va.
SHUTTLE UPPER ATMOSPHERE MASS SPECTROMETER (SUMS)
R. C. Blanchard 804-865-3984

The primary technological objective is to provide flight data for advances in the prediction of aerodynamic behavior throughout the high-speed flight regime, including the free molecular flow and the transition into hypersonic continuum. This objective will be achieved through shuttle orbiter flight instrumentation, including a shuttle upper atmosphere mass spectrometer (SUMS). The specific objective of the SUMS system is to provide in situ high altitude atmospheric data, primarily neutral atmospheric mass density measurements. A spare Viking flight-qualified mass spectrometer will be modified to provide atmospheric data in the rarefied low flight regime. These data, coupled with data from other proposed experiment systems, will provide aerodynamic information on a winged entry vehicle in flight regimes heretofore unobtainable and will augment ground-based test facilities. In addition, experiment results on the shuttle will provide a benchmark from which to evaluate additional entry technology research. The design, construction, and system tests of the prototype shuttle upper atmosphere mass spectrometer (SUMS) and the supporting analysis on the SUMS system design and implementation will bring the experiment to the flight readiness state.

W84-70267 **506-63-39**
Ames Research Center, Moffett Field, Calif.
OEX THERMAL PROTECTION EXPERIMENTS
H. K. Larson 415-965-5369
(506-53-31; 506-51-11)

The overall objective of these experiments is to obtain a better understanding of thermal protection system (TPS) reentry heating effects that may permit TPS cost and weight reductions for the current shuttle and for advanced aerospace vehicles. Four separate experiments will be flown as test panels or tiles replacing baseline TPS on the shuttle orbiter during development and operational flights. These experiments will take advantage of the actual entry heating environment that cannot be fully simulated in ground facilities to investigate TPS heating effects and to demonstrate

advanced TPS materials for possible orbiter retrofit and for application to advanced vehicles. Data will be obtained with existing and follow-on orbiter instrumentation. Baseline TPS procedures and tooling will be used to the maximum practical extent, and none of the experiments will impact orbiter operations. The experiments will be designed, developed, and fabricated through both in-house and contracted efforts, and experimental hardware will be provided as government furnished equipment.

W84-70268 **506-63-40**
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE ORBITER FLYING QUALITIES CRITERIA (OEX)
D. T. Berry 805-258-3140

Experience with high-performance aircraft was used extensively to establish handling qualities and flight control system criteria, specifications and design guides for the atmospheric flight phases of the space shuttle. With the opportunity of test data from the forthcoming orbiter flight test, the adequacy of the existing criteria can be evaluated to provide a sound basis for improvements of the orbiters and to establish validated criteria to support the development of second generation orbiters. Pilot comments and ratings will be obtained for essential tasks throughout the reentry and landing phases of the orbiter flight tests. Studies will be initiated to develop suitable criteria, in the event that the present criteria are found to be inadequate. Pilot ratings and comments will be correlated with vehicle characteristics obtained from analysis of stability and control maneuvers performed during shuttle flight tests.

W84-70269 **506-63-42**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX ADVANCED AUTOPILOT
T. Humphreys 713-483-3546
(506-63-31)

The objective of the OEX Advanced Autopilot experiment is to verify in flight a new and unique autopilot which employs a multi-dimensional phase space rotational and translational control law as an improvement over conventional autopilots which use two dimensional phase plane rotation-only control laws. The advanced autopilot will also employ an optimizing linear jet select algorithm. The new autopilot is principally software which is to be programmed into a shuttle flight computer for the experiment. There its performance can be compared with that of the existing shuttle autopilot.

W84-70270 **506-63-43**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION ACCELEROMETER PACKAGE (HIRAP) EXPERIMENT DEVELOPMENT
R. C. Blanchard 804-865-3984

The primary objective is to provide accurate measurements of low level aerodynamic acceleration along the shuttle orbiter roll, pitch, and yaw axes in the rarefied flow flight regime. This flight data supports advances in the prediction of aerodynamic behavior of winged entry vehicles in the high-speed, low density flight regime, including the free molecular flow and the transition into the hypersonic continuum. The data provides for the measurement of the lift to drag ratio in the rarefied flow flight regime. An orthogonal triaxial set of linear accelerometers, will be mounted on the existing orbiter experiment (OEX) ACIP/PCM mounting shelf. Hardware development and integration aspects are accomplished by NASA-JSC, OEX Project Office under a modification to current ACIP-I development. Studies under this RTOP will be performed to support the design, development, and calibrations of the HiRAP to achieve experiment objectives. In addition, data reduction algorithms will be designed, developed, tested, and applied on multiple flights of the HiRAP.

W84-70271 **506-63-44**
Jet Propulsion Laboratory, Pasadena, Calif.
SHUTTLE PAYLOAD BAY ENVIRONMENTS SUMMARY
D. Kern 213-354-3158

The objectives of the task are to validate STS payload bay dynamic and thermal environments, prediction models, and test methods to provide the STS payload community with the basis for derivation of realistic dynamic and thermal environments design and test criteria for STS launched payloads. The approach will be to conduct engineering analysis of the STS payload bay flight dynamic and thermal data, summarize the data, and publish summary and conclusions reports at appropriate intervals. The reports will provide engineering interpretation of the data gathered and analyzed for the payload bay, particularly data obtained as part of the NASA DATE activity. A literature search and a survey of NASA centers, the Air Force, and Industry will be conducted to obtain information appropriate for inclusion in the report. The flight data acquisition and data reduction systems will be discussed in the report. Statistical methods will be employed to summarize the data and to account for data uncertainties where appropriate. Comparisons with predictions made from analysis and test results will be presented. JPL will be the lead center for this task, with support provided by GSFC through the DATE Working Group.

Platform Systems Research and Technology

W84-70272 **506-64-10**
Langley Research Center, Hampton, Va.
SPACE STATION SUBSYSTEMS OPERATIONS SIMULATION MODEL DEVELOPMENT
R. W. Buchan 804-865-2486

The objective is to determine the viability of reducing space station operations costs by developing a system operations simulator capable of analyzing the interaction between subsystem performance, ground and on-orbit crew activities, automation, and autonomy. The approach shall be to: (1) define architecture and requirements for a subsystem operations simulator; (2) survey the technology of operational simulators and establish the relevance of this technology to space station including consideration of support requirements (hardware, software, people); (3) select one of the subsystem test beds and implement an operations simulator to demonstrate the use of operations simulation; and (4) evaluate demonstration results and extrapolate performance to full system implementation.

W84-70273 **506-64-11**
Lyndon B. Johnson Space Center, Houston, Tex.
FUNCTIONAL SIMULATION/EMULATION OF SPACE STATION INTEGRATION USING THE ECLSS SUBSYSTEM
Scott J. Anderson 713-483-2566

The objective of this effort is: (1) to define and develop several methodologies to simulate/emulate the integration of the space station using the environment control and life support subsystem (ECLSS); (2) to test these methodologies for early operational and functional knowledge of integration techniques; and (3) to evaluate the effectiveness of these methodologies in significantly reducing space station design, development and operational costs. The initial task will be to develop top-level requirements and assess the level of detail required. Then, several conceptual designs will be drawn up based on the requirements. From the design, algorithms can be written, debugged and tested.

W84-70274 **506-64-12**
Lewis Research Center, Cleveland, Ohio.
SPACE STATION PROPULSION REQUIREMENTS
Martin E. Valgora 216-433-6983
(506-60-42; 506-55-22)

The objective of this effort is to define and develop system level technology requirements for chemical and electrical propulsion systems and power for electrical propulsion applicable to the space station mission. These studies will develop a technology and cost data base to assist in guiding decisions on which propulsion technologies have the highest potential. These studies will determine performance requirements, identify system constraints, estimate cost, weight and size of potential propulsion systems,

identify new technology needs, determine benefit/cost ratios and identify priorities of proposed technology programs.

W84-70275 **506-64-13**
Langley Research Center, Hampton, Va.
TECHNOLOGY SYSTEMS ANALYSIS ACROSS DISCIPLINES FOR MANNED ORBITING SPACE STATIONS
L. J. DeRyder 804-865-2486

The objective of the RTOP is to develop system optimization trades across subsystems to determine the maximum technology improvement for permanently orbiting space station systems. System analyses and interdiscipline interaction sensitivity studies will be performed to define technology drivers and priorities for high leverage discipline technology programs. Multidisciplinary systems analysis/optimization methodology and techniques will be developed which provide for modular evolutionary on-orbit growth with advanced technology to satisfy national needs for improved performance while minimizing life cycle costs. System/subsystem interface architecture requirements will be investigated to both enable and optimize the evolutionary expansion of functional on-orbit system capability. An analytical capability for performing life cycle/technology cost benefit assessments will be developed.

W84-70276 **506-64-14**
Langley Research Center, Hampton, Va.
PHASED EMULATION/SIMULATION OF SPACE STATION SYSTEMS AND SUBSYSTEMS FUNCTIONAL CHARACTERISTICS
John B. Hall 804-865-2486

The objectives of this effort are to: (1) develop emulation/simulation models of evolving space station system concepts; (2) exercise these models to provide early operational and functional knowledge of the systems; and (3) evaluate the effectiveness of these models to aid in significantly reducing space station design, development, and operational costs. A model will be developed and operated for a space station subsystem to demonstrate the usefulness of the technique to reduce costs. In addition, a system level functional emulation/simulation model of a generic space station will be developed for use as the basis for developing a more detailed model as the space station definition and design evolves.

W84-70277 **506-64-15**
Jet Propulsion Laboratory, Pasadena, Calif.
AUTONOMOUS SPACECRAFT SYSTEM TECHNOLOGY
Philip R. Turner 213-354-5643

The work in this RTOP will be directed toward the application of autonomy to space station elements. A primary goal will be to identify technologies applicable to autonomous space station functions and determine the suitability of these technologies to support the evolution of autonomous functions towards more complex missions that will develop over the long lifetime of the space station systems. Four major areas of interest will be pursued in the process of analyzing applicable technologies. Autonomy architecture will involve the partitioning of functions between ground and space resources, selection of functions for machine or man-supervised autonomy, allocation of autonomous function responsibilities to system or subsystem level resources, and the use of alternative architectures to ease the development of autonomy. Man-machine interface considerations will be examined to derive an understanding of the cost/benefits realized by implementation of autonomy. They will also identify major design considerations for machine autonomy that will allow the crew to have visibility into the functioning of autonomy and insure the safety of these functions. Expert systems techniques will be examined for their applicability to space system functions. A concept of expert systems design will be defined, functions will be grouped into sets that could potentially be implemented in expert systems, and implementation technology needs will be defined. Software technology will be examined to determine the potential application of developing technology and the impacts of expert systems design for spacecraft functions on software technology.

W84-70278 **506-64-16**
Goddard Space Flight Center, Greenbelt, Md.
SYSTEM ANALYSIS
E. B. Connell 301-344-7992

The objectives of this RTOP are to develop data system concepts, identify critical technology needs, assess potential system configurations, and analyze standard interfaces and protocols for late 1980's and post-1990's missions such as the Upper Atmosphere Research Satellite (UARS), Origin of Plasmas in the Earth's Neighborhood (OPEN), space station, and possible unmanned space platforms. The RTOP approach is to obtain initial mission, science, and technology goals from project plans and science working groups, develop and investigate data system concepts to support those goals, and identify critical technology areas. Since, in many cases, it is desirable to identify the latter as quickly as possible, this work is performed by examining mission systems in an end-to-end sense, then refining the results as requirements evolve. In order to avoid duplication of effort and to take advantage of many government and commercial activities in the area of data system standardization, the efforts of organizations such as the NASA/ESA Working Group, the National Bureau of Standards, the Consultative Committee on Space Data Systems, and the International Organization for Standardization are surveyed for applicability to the particular needs of NASA's future missions. In some cases, the work of these groups is adopted; in other cases, areas where data system standards are needed are identified to the appropriate group(s) for action. Results from this RTOP contribute directly to the development and establishment of such standards.

W84-70279 **506-64-17**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION DATA MANAGEMENT SYSTEM ANALYSIS/ ARCHITECTURE STUDY
W. E. Mallary 713-483-3066

This task will develop a system architecture design and implementation strategies for the orbiting space station (SS) data management system (DMS). This will be accomplished through a system design process consisting of: (1) the definition and characterization of SS facility and user subsystem functions in sufficient depth to identify data managemet requirements; (2) the identifiction and evaluation of technology, design, and management options; and (3) trade studies which investigate the interrelationships between major SS programmatic issues and options; program goals and objectives; and technology and design options. The derived system design and implementation planning will be periodically updated in response to programmatic developments, requirements changes, and other development information which occurs during the contract period of performance.

W84-70280 **506-64-18**
Marshall Space Flight Center, Huntsville, Ala.
SPACE STATION SYSTEMS TECHNOLOGY
W. O. Frost 205-453-1413

This RTOP includes three tasks related to space station systems research and technology. Task 01, space station automation, investigates and assesses the use of automation in the control and management of space station subsystems. It established a demonstration of expert system techniques. Task 02, servicing and operations/model, defines and investigates systems configurations and operation alternatives for a remote servicing system. Task 03, simulation/emulation, develops math model formats, user documentation, and configuration management for a data base of space station systems.

W84-70281 **506-64-19**
Marshall Space Flight Center, Huntsville, Ala.
SPACE STATION SYSTEMS ANALYSIS
Ron E. Jewell 205-453-0436
(506-62-69; 906-58-02)

This RTOP is comprised of two tasks, each addressing specific target areas within the Space Systems Analysis Objective. Task 1, Space Station Systems Technology Analysis, is a systems level

trades study focused at defining the high-priority, high-leverage, technology drivers at the component and subsystem level that are enabling to early space station mission requirements. The FY-84 Task 1 activity will be a continuation of an on-going study effort that will focus on special emphasis areas requiring additional depth of understanding. The second task, Task 2, has the objective of assessing and demonstrating the application of expert system concepts to the automation, control, and management of space station subsystems. Potential benefits of an adaptive software (i.e., expert system) approach such as ease of modification, efficient man-machine interface, self-documenting capability and effective accommodation of complex decision making processes will be evaluated. Initial emphasis is to be placed on automation of the space station power system, as a representative candidate for expert system application. Subsequently, at least one other space station subsystem will be included in order to assess and demonstrate an integrated expert system operation involving multiple subsystems.

W84-70282 **506-64-23**
Langley Research Center, Hampton, Va.
TELEOPERATOR AND ROBOTICS SYSTEM ANALYSIS
A. J. Meintel 804-865-2489
(506-54-63; 506-57-23)

The objective of this effort is to generate an integrated systems simulation analysis tool for evaluation of teleoperator and robotic systems capable of remote space operations. It will also evaluate at the systems level, subsystems and components and identify high leverage areas requiring research to enable remotely controlled manipulator systems which outperform direct human manipulation. An integrated modular software simulation coupled to a manned control station will allow system level integration and analysis studies of remotely-controlled vehicles capable of space operations. The near-term approach will be to implement in the teleoperator and robotic systems simulation (TRSS) software models representing the remote orbital servicing system (ROSS) concept. The TRSS will enable systems integration and evaluation of emerging concepts in robotics. The output of the simulation will supply specifications for the design, construction, and testing or remote systems.

W84-70283 **506-64-24**
Lyndon B. Johnson Space Center, Houston, Tex.
ANALYTIC, END-TO-END SPACE STATION OPERATIONS MODEL (SSOM) FEASIBILITY STUDY USING STS OPERATIONS EXPERIENCE
L. C. Krchnak 713-483-3829
(506-64-17; 480-40-20; 506-64-27)

The objective of this program is to provide shuttle man/system interaction experience in support developing a space station operations computer model to be used in conducting feasibility testing of a space station operations simulation model. The approach is to: (1) define requirements/uses for operations model; (2) identify areas of man/system operational interaction suitable for modelling; (3) define approaches to modelling one to three key areas; and (4) incorporate key area models into a strawman space station operations model to test feasibility.

W84-70284 **506-64-25**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED THERMAL CONTROL TECHNOLOGY FOR CRYOGENIC PROPELLANT STORAGE
G. A. Klein 213-354-4116
(506-60-29; 506-52-25)

The objective of this RTOP is to provide the technology for long-life, low-mass active cooling systems for cryogenic propellant thermal control applications. Thermally driven absorption (adsorption) compressors/Joule Thompson (JT) refrigerators can potentially meet these requirements. The approach consists of assessments to identify attractive thermally-driven refrigeration system/propellant storage system designs and optimum operating parameters. Experiments will be performed to test the new design or modified design of the absorption compressor/JT refrigerator system components in order to improve heat transfer characteristics into the refrigerator or compressor.

W84-70285 **506-64-26**
Goddard Space Flight Center, Greenbelt, Md.
IN-SPACE FLUID MANAGEMENT TECHNOLOGY - GODDARD SUPPORT
Allan Sherman 301-344-5405

This RTOP provides manpower to support the Cryo-Space Fluid Management Program managed by the Lewis Research Center. Details of the program are in the Lewis RTOP. The Cryogenics, Propulsion and Fluid Systems Branch will provide technical consultation on the supply task of the Cryogenic Fluid Management Facility, review facility specifications, and design concepts, and check analyses. The justification for the program is in the primary RTOP. The involvement of Goddard has been approved in a Memorandum of Agreement signed by the Directors of the Lewis Research Center and the Goddard Space Flight Center Directors. As part of the technical consultation on the supply tank system of the Cryogenic Fluid Management Facility, all facility specifications and design concepts will be informally reviewed, analyses will be checked, and the final design will be reviewed. Suggestions for modifications or design improvements shall be transmitted in a timely manner to the principal technologist.

W84-70286 **506-64-27**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION OPERATIONS TECHNOLOGY
W. K. Creasy 713-483-2561

The objectives of this RTOP effort in the area of construction/docking technology are (a) establish system design requirements and operating procedures for docking/berthing maneuvers required for construction, assembly, and satellite servicing tasks, (b) identify component technology needs and systems design drivers through analysis of the projected program requirements, including requirements for minimum disturbance soft docking/berthing, and (c) demonstrate validity of system and component design and operational concepts through full-scale ground tests of development hardware. This will be achieved by developing requirements, performing conceptual design studies, performing parametric trade studies, and developing prototype hardware for proof-of-concept systems ground tests. A second objective in the area of cryogenic fluid management is to identify and evaluate attractive technical concepts for a liquid hydrogen quantity gauge for zero-gravity use in support of the Lewis Research Center's Cryo-Fluid Management Facility. As an additional task, a third objective in support of the space station is to develop technology to make effective use of the space station flight crew and support cost-effective operations of the space station.

W84-70287 **506-64-28**
John F. Kennedy Space Center, Cocoa Beach, Fla.
GROUND OPERATIONS SEGMENT OF THE TOTAL SYSTEM SERVICING AND OPERATIONS COMPUTER MODEL
Randy Tilley 305-867-3017

The objective of this project is to provide the ground operations segment of the total System Servicing and Operations Model which will be synthesized at LaRC. This is an intercenter effort involving LaRC, JSC, KSC, and MSFC. The approach at KSC is to adapt and augment appropriate portions of ongoing space station studies and modelling efforts.

W84-70288 **506-64-29**
Marshall Space Flight Center, Huntsville, Ala.
TELEOPERATORS AND CRYOGENIC FLUID MANAGEMENT
W. O. Frost 205-453-1413

This RTOP includes two areas of activity: (1) teleoperations and (2) cryogenic fluid management. In teleoperations, a representative set of space teleoperator tasks emphasizing remotely controlled manipulation is defined. The resulting teleoperator requirements are identified and assessed, and a ground-based empirical investigation and technology demonstration is performed to determine teleoperator parameters for verification of software

simulations and to investigate development/technology options. In the area of cryogenic fluid management, an analytical/experimental assessment of the thermodynamic, fluid mechanic, and heat transfer interactions between components and subsystems within a liquid hydrogen management system for orbital propulsion is performed. A large scale test article is used in conducting the experimental tests. Results provide design guidance for OTV's, transportation of cryogenic fluids to a space station, supporting orbital low-gravity experiments and comparing data with normal gravity results. Technologies involved in the development of reusable cryogenic insulations are also investigated. This effort is in support of the Cryo-Fluid Management Program managed by the Lewis Research Center.

W84-70289 **506-64-30**
Ames Research Center, Moffett Field, Calif.
ECLSS TECHNOLOGY SPACE STATION AUGMENTATION
P. D. Quattrone 415-965-5733
(506-64-31; 199-60-12; 199-60-22)

The objective of this program is to develop partially closed regenerative life support subsystem technology and EVA and suit technology for space station. The specific technology areas included in this RTOP are: electrochemical depolarized carbon dioxide concentration, space suit thermal protection, and design of backpack and on-orbit servicing system.

W84-70290 **506-64-31**
Ames Research Center, Moffett Field, Calif.
SPACE STATION LIFE SUPPORT TECHNOLOGY
P. D. Quattrone 415-965-5733
(199-60-12; 199-60-22)

The objective of this program is to develop space station crew/life support technology in air revitalization, water reclamation and solid waste management to support the establishment of permanent human presence in space. This program objective includes technology development to support the initial space station and for later space station growth. The long-range program goal is to achieve a technology-ready condition for regenerative life support system technology for the initial space station and improved process efficiencies, increased system closure and additional personal accommodations for space station growth. The specific technology areas in this RTOP include: electrochemical depolarized CO2 concentration; static-feed water electrolysis O2 generation; nitrogen generation; solid amine CO2 concentration; integrated air revitalization; supercritical water waste oxidation; and thermal control.

W84-70291 **506-64-37**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED LIFE SUPPORT TECHNOLOGY FOR SPACE STATION
A. F. Behrend 713-483-4823

This RTOP is in direct support of the space station development program and reflects the recommendations made by the Crew and Life Support Working Group to the OAST Space Station Technology Steering Committee. The objectives are to secure a mature regenerative life support technology base for an early 1990 space station launch and to provide backup technology readiness in regenerative life support. These objectives are to be directed at atmosphere revitalization, atmospheric quality monitoring, water reclamation, water quality monitoring and water potability determination.

W84-70292 **506-64-38**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED LIFE SUPPORT TECHNOLOGY AUGMENTATION FOR SPACE STATION
A. F. Behrend 713-483-4823

This RTOP is in direct support of the space station development program and reflects the recommendations made by the Crew and Life Support Working Group to the OAST Space Station Technology Steering Committee. The objectives are to augment the technology base for regenerative life support and extravehicular equipment in support of a 1991 space station initial operational capability. These objectives are directed to increase regenerative subsystem overall efficiency, increase the pressure capability of the oxygen generation subsystem without the addition of a mechanical pump, reduce gas/liquid handling problems, and to develop extravehicular life support and space suit configuration concepts that provide on-orbit astronaut space suit resizing, maintenance, extended operating life, and automated checkout capability.

W84-70293 **506-64-45**
Jet Propulsion Laboratory, Pasadena, Calif.
INFORMATION SYSTEMS NETWORK CONCEPTS, STANDARD INTERFACES AND PROTOCOLS
Adrian J. Hooke 213-354-3063
(506-58-15; 506-54-55)

This work is comprised of two tasks which respond directly to Program and Specific Objectives (PASO) targets. Overall coordination of the RTOP is the responsibility of A. J. Hooke. The objectives of the tasks are: (1) to develop simple top-level reference models which conceptualize an advanced end-to-end architecture for the space and ground data networks which support the space station; (2) to expand the reference models into a set of candidate functional 1990's design configurations, and to demonstrate at a conceptual level how evolving NASA capabilities may become components of the future confederated Space Station Data Network; (3) to continue development of a core set of generic, NASA-wide, multimission standard data interfaces and protocols which can enable the development of low-cost, high-performance automated data handling networks within the Agency; (4) to customize the generic protocols for application within the space station program; and (5) to determine which systems design methodologies and tools prove to be useful in the excution of these complex architectural and functional design tasks. The approach to meeting these objectives will be to conduct system-level architectural studies, and in parallel to develop specific standard interfaces and protocols which will be directly applicable to high-performance low-cost space station automated data network design.

Interdisciplinary Technology

W84-70294 **506-90-21**
Ames Research Center, Moffett Field, Calif.
INTERDISCIPLINARY TECHNOLOGY - FUNDS FOR INDEPENDENT RESEARCH (SPACE)
S. N. Davis 415-965-5113
(505-90-21)

The object of this RTOP is to support innovative and discretionary basic research in areas related to space. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical fields of lasers, energetics, materials, applied mathematics, superconductivity, chemistry and physics. The OAST Research Council and the Ames Basic Research Council review unsolicited proposals that have been judged to be worthy of support on scientific or engineering grounds, but have not been selected for support because of funding limitations in other research programs. Those research proposals that are judged by the Council and the ABRC to be worthy of support on a scientific or engineering basis are selected as candidates for funding.

W84-70295 **506-90-22**
Lewis Research Center, Cleveland, Ohio.
FUND FOR INDEPENDENT RESEARCH (SPACE)
Marvin E. Goldstein 216-433-4000
(505-90-22)

The objective is to conduct innovative, long-range, high-risk, basic research in areas related to space. The program pursues basic investigations of, and facilitates exchange of information

about new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space. The program is carried out primarily through grants which are selected by the Chief Scientist with the aid of the Research Advisory Board. It allows OAST to initiate fundamental studies in areas not presently included in a specific discipline program. The funds are also used to bring speakers and visiting university scientists to the Lab and to hold workshops and seminars.

W84-70296 **506-90-23**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (SPACE)
R. H. Tolson 804-865-2664
(505-90-23)

The objective of this plan is to support basic research programs in universities in areas related to space through the funding of a limited number of unsolicited research proposals. University research proposals that have been evaluated and are not funded through any of the research programs are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be well worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be more innovative and aimed at the longer term research of potential relevance to future NASA space programs.

Space Systems Technology Programs

Spacecraft Systems Technology

W84-70297 **542-03-01**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF A SHUTTLE FLIGHT EXPERIMENT: DROP DYNAMICS MODULE
T. G. Wang 213-354-6331

The principal objective of this RTOP is to design, fabricate, and test an acoustic positioning and manipulation module to utilize it to perform the experiment 'Dynamics of Rotating and Oscillating Drops and Bubbles' as part of the NASA Spacelab III and subsequent missions. This acoustic positioning and manipulation module will allow us to utilize the unique zero-g environment provided by a Shuttle/Spacelab flight to perform drop and bubble dynamics experiments that are impossible to perform in a gravitational field. Examples are: (1) study experimentally the equilibrium figures and the bifurcation process of a rotating spheroid; (2) investigate the non-linearity in the resonant frequencies as a function of oscillation amplitude; and (3) understand the fission and fusion processes in drops that pertain to other disciplines. The scope of this work is twofold: first, to fabricate a flight unit, and second, to perform the experiment 'Dynamics of Rotating and Oscillating Drops and Bubbles' as part of the NASA Physics and Chemistry in Space Program. The scientific community will be invited to participate in experiments informally through international symposia and colloquia. Some scientists will participate with JPL as science associates and consultants.

W84-70298 **542-03-04**
Marshall Space Flight Center, Huntsville, Ala.
DYNAMICS AUGMENTATION EXPERIMENT (DAE)
Henry C. Hill 205-453-3423
(506-55-49)

The objectives of the SAE Dynamics Augmentation Experiment (DAE) are to develop and demonstrate the technology readiness of on-orbit remote sensing and data processing systems for subsequent use in large space structure dynamic response measurements, and to process data obtained from the remote sensing tests, to define solar arrays dynamic characteristics for correlation with theory, and ground test data applicable to large flexible space systems. The approach consists of developing/flight qualifying/flight verifying remote sensing and recording systems for measuring Solar Array Experiment X and Y coordinate motions obtained from controlled Orbiter VCS firings; and correlating flight data with analytical/ground test data to define orbit peculiar characteristics.

W84-70299 **542-03-12**
Lewis Research Center, Cleveland, Ohio.
CRYOGENIC FLUID MANAGEMENT TECHNOLOGY
G. R. Smolak 216-433-6632

The broad objective of the Cryogenic Fluid Management Program is to provide the technology base to enable the design of efficient systems for the management of cryogenic fluids in the space environment includng storage, acquisition (positioning) and fluid transfer. The approach is broad based ranging from fundamental research to applied technology; it includes the development of analytical models and scaling analysis and the required experimentation to verify those models. Required experimentation are both ground and space based. The program is a multi-center effort with LeRC, MSFC, JSC, GSFC and KSC participating and LeRC serving as the lead center. There are two primary program thrusts: applied system and component technology and fluid management fundamental research. Development of the Cryogenic Fluid Management Facility (CFMF) as a reusable test bed to be carried into space aboard the shuttle is an integral part of the thrust in applied system and component technology. In-space testing with flight hardware in addition to the CFMF will be required to achieve the fluid-management fundamental objectives.

W84-70300 **542-03-13**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACELAB 2 SUPERFLUID HELIUM EXPERIMENT
P. V. Mason 213-354-4056

An experiment to investigate the properties of superfluid helium in zero gravity was planned for flight on Spacelab 2 in early 1983, and now is scheduled for flight in March, 1985. The experiment will determine the mechanical and thermal properties of superfluid helium in sufficient detail to enable the design of high-performance, space-qualified superfluid in cryogen systems. A companion experiment will study the properties of low velocity capillary waves in thin films of superfluid helium. These waves cannot be observed in the Earth's gravity. Their study will increase scientific understanding of the interaction of normal and superfluid helium. The experiment will consist of an instrumented cryostat, an experiment package mounted inside the cryostat, and an electronics control and data processing electronics package. It will be mounted on a Spacelab pallet, and will interface with the Spacelab Command and Data Management System. Interactive control with experimenters on the ground will permit optimization of scientific results by real-time modification of experimental conditions and parameters.

W84-70301 **542-03-14**
Langley Research Center, Hampton, Va.
FILE FLIGHT EXPERIMENT SUPPORT
W. E. Sivertson 804-865-3666

The objective of this RTOP is to support FILE flight experiment activity and the advancement of feature classification and cloud detection technology. Work will include in-house and contract support for the refurbisment, testing, integration, collection of experimental data, and post-flight technology evaluation and publication of results relative to the FILE/OSTA-3, STS-17 flight. Instrumentation parameters will be assessed relative to in situ flight performance. Principal investigator participation in FILE operations and data collection and evaluation will be included. Results from this effort will focus on providing new knowledge required for autonomous cloud detection, pointing, and tracking instruments for future missions.

W84-70302 **542-03-20**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE CALIBRATION OF SOLAR CELLS
L. Sidwell 213-354-5489
(506-55-45)

The objective of this RTOP is to take advantage of the true space environment provided by the STS program to calibrate a group of solar cells. Data will be gathered during the currently scheduled flight of the Solar Cell Calibration Facility (SCCF) on STS 14 during May of 1984. Data gathered on this STS flight will be compared with the data gathered from the same solar cells flown on a high altitude balloon during July of 1984. All data will be reduced, analyzed and cross compared to determine the ability of the balloon flight to provide AMO (true space) calibrated solar cells. A final report will be prepared covering the program results and recommending the most cost effective cell calibration method.

W84-70303 **542-03-30**
Langley Research Center, Hampton, Va.
CRYSTAL GROWTH IN SPACE
R. K. Crouch 804-865-3777
(179-80-70)

The objective of this program is to utilize the reduced gravity environment of the space shuttle to determine the effect of gravity driven convection currents on the quality of compound semiconductor crystals. To accomplish this objective a series of experiments will be designed and fabricated to fly onboard the shuttle. The first experiment is scheduled for launch in March 1984. These experiments, supported by ground-based research, will provide data on important parameters needed to improve ground-based crystal growth. The effort in 1983 was primarily directed toward characterizing the shuttle furnace and designing an experiment that is compatible with it. It is expected that the characterization studies will be concluded during the coming year, theoretical calculations will be done to determine the expected results, as predicted by current theory, and the flight experiment will be carried out and analyzed to provide a comparison between ground-based results and those obtained in space.

W84-70304 **542-03-40**
Lyndon B. Johnson Space Center, Houston, Tex.
ATOMIC OXYGEN EFFECTS ON MATERIALS
L. J. Leger 713-483-2059

Atomic oxygen within the low earth orbital ambient environment is known to be extremely reactive whenn impinging on solid surface. Chemical changes can occur for spacecraft materials at orbital altitude which alter optical and electrical properties and, in some cases, even remove layers of material. If the atoms impinge with kinetic energy of orbital velocity (approximately 5 eV for atomic oxygen), chemical reactions are accelerated and the mass loss for many materials becomes more pronounced. The objectives of this RTOP are to design, develop and conduct flight experiments to assess the response of selected space materials to the atomic oxygen environment and to identify and confirm the mechanisms of erosion and associated reaction rates. Secondary objectives include correlation of atom/surface interactions with surface glow investigations conducted by OSSA. Principal tasks include selection and preparation of material specimens, experiment design and development, Orbiter integration and mission definition and post-flight analysis. To complete this RTOP, flight test results will be summarized in final reports issued by JSC and contributing NASA centers.

W84-70305 **542-03-42**
Lewis Research Center, Cleveland, Ohio.
TWO PHASE FLUID RESEARCH FOR THERMAL MANAGEMENT
Thomas L. Labus 216-433-6233
(506-55-82)

The objective of this effort is to conduct research in space on fundamental two phase fluid dynamics and heat transfer to provide the research and technology base for the design of advanced thermal management systems utilizing two phase flows for space station applications. The program will consist of the development of experimental hardware and the conduct of research aboard the orbiter middeck of shuttle. LeRC will provide the technical and management support to direct all contract activities and to provide coordination between Government groups, contractors and the scientific community associated with these efforts.

W84-70306 **542-03-43**
Langley Research Center, Hampton, Va.
SPACE FLIGHT EXPERIMENTS (STRUCTURES FLIGHT EXPERIMENT)
J. L. Allen 804-865-3661

The objective is to conduct space flight research focusing upon structural performance, dynamics, and control of flexible, low-frequency space structures utilizing a deployable joint-dominated truss beam as the test article. Through the selection, fabrication, and test (ground and space based) of a large space system structural section, one is able to explore and define the structural and dynamic boundaries of flexible, efficiently designed space systems. The test article, being retractable, may be used repeatedly as the host for a series of research flights from the Structures Technology Experiments Program (STEP) experiment carrier.

W84-70307 **542-03-44**
Langley Research Center, Hampton, Va.
SPACE FLIGHT EXPERIMENTS (STEP DEVELOPMENT)
J. E. Harris 804-865-3661

The objective is to define and develop a low-cost reusable shuttle-borne Structures Technology Experiments Platform (STEP) to be used in conjunction with the shuttle as a space testing facility to accommodate flight experiments primarily in the structures, structural dynamics and structures/controls interaction research disciplines. The aproach will be to: (1) form a project office and an in-house design team augmented with contract personnel and conduct feasibility and system definition studies; (2) develop project plan and necessary project documentation to initiate project implementation; and (3) manage the project development and subsequent flight operations.

W84-70308 **542-03-45**
Jet Propulsion Laboratory, Pasadena, Calif.
PROPULSION/CONTAMINATION MONITORING (IN-SITU)
C. R. Maag 213-354-6453

This RTOP supports the specific objective of characterizing the exhaust plumes from liquid rocket engines, solid rocket motors and electric thrusters. Specifically, this effort will identify a number of current or planned orbital free flyer DOD and NASA mission payloads. These payloads will be instrumented to measure several exhaust plume characteristics. The monitoring instrumentation will be designed and fabricated to measure various types of rocket propulsion systems. The instrumentation will measure plume characteristics such as backflow and core flow mass efflux, electrical charge buildup, forces, torques, heating rates and the subsequent effects to the radiative properties of several typical thermal control and optical surfaces.

W84-70309 **542-03-46**
Goddard Space Flight Center, Greenbelt, Md.
THERMAL ENERGY MANAGEMENT PROCESS (TEMP) #2
Stanford Ollendorf 301-344-5228
(506-55-86)

The objectives are: (1) to test performance of critical components and subsystems such as evaporators, condensors, capillary pumps and O-G designed heat pipes in the space environment; and (2) to integrate these components and subsystems into a complete system flight test. The approach will be to develop experiments, at the component level which can be flown as small payloads on space shuttle; and to build and flight test a complete system including data acquisition and command capability on a convenient payload carrier. In FY-84 it is expected that a component such as a capillary pump will be flown on a Get Away Special (GAS).

W84-70310 **542-03-47**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL ENERGY MANAGEMENT PROCESSES (TEMP) FLIGHT EXPERIMENT
W. E. Ellis 713-433-2351

The objective of this RTOP effort is to obtain the data base and zero gravity flight verification necessary to provide the confidence required for implementation of two phase thermal systems into flight spacecraft. Specifically, this effort will flight test heat pipe two phase thermal management systems, including the assessment of in space thermal construction and modularity techniques for such systems. The experiment will verify the technology of a large capacity, extended length heat pipe radiator/thermal bus system that can be constructed and maintained under zero gravity operating conditions. The experiment will fully verify proper operation, including passive operation capability, insensitivity to the micrometeoroid environment, insensitivity to the gravity field, and adequacy of the relatively small capillary and surface tension forces critical to proper operation. The relatively large size of the experiment will require that it be carried by the payload bay. However, since the experiment can be made long and narrow if desired, it can easily be packaged of the RMS envelopes and thus be carried with minimal impact on other Orbiter payloads. The hardware to be flown as part of this TEMP experiment program is directly related and in fact are direct outgrowths of the ongoing R and T program in Space Power Systems and planned Space Station Advanced Development Activities. The flight test program will provide the transfer function for R and T two phase/heat pipe technology into the space station development program.

W84-70311 **542-03-48**
Lewis Research Center, Cleveland, Ohio.
ENVIRONMENTAL INTERACTION STS FLIGHT EXPERIMENTS
C. Purvis 216-433-4000
(506-55-72)

The objective of these tests is to obtain the fundamental information base necessary to provide guidelines for the design of a high voltage power system for the space station. In order to provide the high (75kW) power levels required by the space station, the supply must operate at high voltage to reduce current flows to manageable levels and thereby minimize cabling weight and power losses. The test schedule permits the results to be incorporated into the Space Station Phase C/D DDT&E effort. Four STS flight experiments (VOLT-1 to VOLT-4) will be conducted in the near Earth environment. The VOLT-1 will measure plasma interactions with high voltage-biased silicon solar cells using the PIX-2 backup hardware. The VOLT-2 will determine the impact of interactions on the performance of a large planar array. The VOLT-3 will expose a concentrator array segment to space plasma for the first time to scope its plasma interactions characteristics assess damage to optical surfaces. The VOLT-4, like VOLT-2, will expose a large high-voltage, array wire from the shuttle payload bay, but the array will be of high concentration-ratio design.

W84-70312 **542-03-49**
Marshall Space Flight Center, Huntsville, Ala.
VOLAGE OPERATING LIMIT TESTS
M. R. Carruth 205-453-4275

For many years it has been known that unique problems existed relative to the operation of a high voltage solar array in the ambient plasma in LEO. Ground experimental investigations and analytical modeling have been conducted throughout this time in order to understand the phenomena. Much progress has been made; however, it is necessary to obtain data on actual high voltage solar array performance in a plasma. This can only be accomplished in a space test. The data will provide actual operating performance and related data in order to compare with and validate analytical models and ground tests. The objective of this RTOP is to develop an experiment which will provide the required data. This can be accomplished through a reflight of the solar array flight experiment by making required modifications.

W84-70313 **542-04-13**
Langley Research Center, Hampton, Va.
LONG DURATION EXPOSURE FACILITY
Leo P. Daspit, Jr. 804-865-3704

The board LDEF Project objectives are the following: to develop the Long Duration Exposure Facility (LDEF); to develop and perform a first set of experiments on the LDEF; and to broaden the operational STS user community. The LDEF, a shuttle transported, reusable, unmanned, low-cost free-flying structure on which many different experiments can be mounted, will be developed and manufactured in-house at Langley. The experiments, many of which are completely passive with active data measurements being made in the laboratory after recovery, will be solicited from all NASA Centers, other government agencies, industry, and foreign countries. The STS user community will be broadened by LDEF providing a unique, simple, low-cost approach to perform large numbers of needed long duration technology and science experiments. The establishment of a continuing program to provide for LDEF reflights after the the first LDEF mission with the operational STS is a part of this RTOP. The implementation of the established follow-on program is not.

W84-70314 **542-05-12**
Lewis Research Center, Cleveland, Ohio.
FLIGHT TEST OF AN ION AUXILIARY PROPULSION SYSTEM (IAPS)
James F. DePauw 216-433-6119

A major goal of the OAST-LeRC electric propulsion effort is to achieve technology readiness and user acceptance of a high performance, long life mercury ion auxiliary propulsion system for use in the 1980s. Accomplishment of this goal depends on attaining the following objectives: conduct a flight test of a mercury ion auxiliary propulsion system; provide engineering information on the system performance and system interfaces with the spacecraft; and involve potential users in program activities. The approach is to conduct a space flight test of an ion auxiliary propulsion system operated for time duration and duty cycle representative of potential operational missions. The flight system uses two 8-cm diameter mercury ion thrusters operating at one millipound thrust level. The experiment will be flown aboard an AF spacecraft. The program also includes a ground test program to provide data on system performance and interfaces and a principal investigator function to technically guide the program and interact with potential users.

OFFICE OF THE CHIEF ENGINEER

Standards and Practices

W84-70315 **323-51-03**
Jet Propulsion Laboratory, Pasadena, Calif.
HERMETICALLY-SEALED INTEGRATED CIRCUIT PACKAGES: DEFINITION OF MOISTURE STANDARD FOR ANALYSIS
R. F. Haack 213-354-6568

The overall objective of this RTOP is to provide the technology base for a 'package moisture standard' for the mass spectrometric method for determining the moisture content in integrated circuit packages. Presently, state-of-the-art permits only inletting of a calibration gas. A standard package could be analyzed in an identical manner as that used for the packages. For water in the gaseous state, the type of transfer mode(s) is extremely critical and therefore any calibration method should approximate the analysis of the package as closely as possible. The availability of such a standard is vital to the credence of results from laboratories verifying the moisture content of packages as outlined in Mil Std 883B for ensuring functional reliability of integrated circuits. The approach will involve two stages. The first is the fabrication of standard packages that will contain known amounts of moisture in the ranges encountered in commercial integrated circuit packages. The prepared packages will then be analyzed in phase 2 to calibrate the analytical procedure. Reproducibility, accuracy, and sample parameters (size, moisture absorptivity, stability, and leak rate) will be related to the mass spectrometric moisture

analysis. At the end of the second phase, the packages will be suitable as primary standards for any laboratory performing analysis according to Mil Std. 883B for moisture.

W84-70316 **323-51-41**
Jet Propulsion Laboratory, Pasadena, Calif.
ENVIRONMENTAL SIMULATION FOR SOLID STATE DEVICES USED ON SATELLITES AND SPACECRAFT
William E. Price 213-354-4467

The major objective is to determine the physical mechanisms of radiation interactions with solid state devices. This includes the interactions of particles such as electrons, protons and heavier ions in producing degradation of the electrical parameters of semiconductor devices as well as the effect of gamma rays used in simulating ionization effects in laboratory tests. There are several specific areas which require independent approaches. These areas include but are not limited to: (1) Single Event Upset; studies are required to determine the upset mechanism for different classes of devices so as to classify their relative sensitivity to space environment and methods which allow prediction of upset sensitivity and latchup without need for specific device characterization test; (2) Annealing of Total Dose Effects; studies require a physical understanding of the mechanisms at work in total dose radiation effects both during irradiation and during the subsequent annealing after irradiation. This must be determined for the space radiation environment and for laboratory simulation tests; (3) Radiation damage differences due to different radiation types and energies; studies are required to understand the differences obtained between different types of sources and what the implications are in order to properly simulate space radiation effects.

W84-70317 **323-51-61**
Langley Research Center, Hampton, Va.
ADVANCED NON-DESTRUCTIVE EVALUATION (NDE)
Joseph S. Heyman 804-827-3418

The main objective of this effort is to improve the measurement technology for characterizing disbonds, delaminations, and clustered microcracking in composite materials. A major thrust of the program is to develop a noncontacting optical/thermal approach which will have potential for field applicability. A system shall be fabricated and set up under computer control to scan a given sample and evaluate the sample's thermal profile for thermal barriers such as disbonds. This technique has great potential for examination of large structural areas and may play a significant role in structural recertification, especially for assessing impact related damage. The philosophy of this effort is based on diffusion from a focused heated spot on the surface of the sample. Disbonds, microcrack clusters, or delaminations present a significant thermal barrier which affects the time history of heat flow. By monitoring the thermal derivatives at the point of heating with an optical IR technique, significant information of the material state should be available.

W84-70318 **323-51-72**
Jet Propulsion Laboratory, Pasadena, Calif.
SOFTWARE MANAGEMENT AND QUALITY ASSURANCE STUDY
Susan McMahon 213-354-3289

The objective is to provide technical support to the Software Management and Assurance Program, and the objective of this first task is to gather information on current NASA software management and quality assurance practices, covering recent and current projects within NASA. The output from this task will be provided to the Software Management and Assurance Program, and should be relevant to the program's overall goal of establishing policies, standards, and guidelines which will serve to assure the reliability of operational software and reduce the cost and difficulty of planning, developing, and maintaining program and project software. The projects chosen will be representative of the entire spectrum of NASA activities, including aeronautics, manned and unmanned space flights, which can be further divided into flight and ground systems. Priority will be given, however, to mission critical and operational safety software. The approach in attaining the stated objective will be based upon using previous, relevant work available at different organizations, as well as defining objective techniques for collecting software management and assurance data, reducing them, and finally presenting the findings of each (project) survey to the Chief Engineer's Office and the Software Management and Assurance Program's Steering Committee.

W84-70319 **323-51-90**
Jet Propulsion Laboratory, Pasadena, Calif.
NASA CENTERS CAPABILITIES INVENTORY FOR R & QA TRAINING AND SEMINARS
James A. Roberts 213-354-5418

The objective of the RTOP is to provide a central focal point for inventory management of all NASA Centers capabilities for R&QA training and seminars. This will provide a current source for uniform application of the NHBs and NMIs in the R&QA disciplines and provide productivity improvement and quality enhancement for NASA projects. The approach for accomplishing the objective of this RTOP will be: (1) identification of existing capabilities and needs for all NASA Centers; (2) development of the management scheme and organization for a NASA R&QA training and seminar capabilities; and (3) implementation.

W84-70320 **323-52-46**
Marshall Space Flight Center, Huntsville, Ala.
PRINTED WIRING DESIGN GUIDE
J. F. Blanche 205-453-4561

The objective of this RTOP is to develop a NASA Printed Wiring Design Guide which will consolidate the design experience available at all the NASA Centers. The design guide will be coordinated with the existing NASA Workmanship Standards Review Panel and will be released as a NASA Handbook.

W84-70321 **323-52-49**
Marshall Space Flight Center, Huntsville, Ala.
FLIGHT ELECTRONICS REWORK/REPAIR
J. F. Blanche 205-453-4561

The objective of this task is the development of 'standard' rework/repair methods, substantiated by up-to-date test data, and the revalidation of NASA imposed packaging design criteria and associated workmanship requirements for printed wiring assemblies. These rework/repair techniques backed by realistic test data can be readily incorporated into existing electronic hardware to salvage assemblies requiring late engineering changes or damaged during the manufacturing process. The data generated during the revalidation effort will be used to update NASA requirements and provide a firm data base for more realistic evaluation of contractor requested departures from the electronic packaging design criteria.

W84-70322 **323-52-60**
Langley Research Center, Hampton, Va.
DEVELOPMENT OF THE NASA METROLOGY SUBSYSTEM OF THE NASA EQUIPMENT MANAGEMENT SYSTEM
F. A. Kern 804-928-2801

A metrology control subsystem will be developed as part of the NASA Equipment Management System (NEMS). This subsystem, to be used by all NASA Center metrologists, will include standardized historical and calibration recall programs consisting of calibration data, recall data, calibration interval data, calibration and repair labor and material costs. The requirements will be developed by the NASA Center metrologists through the Metrology and Calibration Workshop. The development of standardized input data formats, flow charts, transaction specifications, complete programs, standardized information data reports, and a user manual will be accomplished on contract. This subsystem, following development at LaRC, will be implemented concurrently with NEMS at the other field centers.

W84-70323 **323-53-01**
Lyndon B. Johnson Space Center, Houston, Tex.
THE DEVELOPMENT OF METHODS AND PROCEDURES FOR DETERMINING THE IGNITABILITY OF METALS IN OXYGEN
Frank J. Benz 505-524-5722

Research, design, develop and demonstrate test methods that will evaluate the compatibility of metals in high pressure oxygen systems. The approach is to evaluate five test methods which are in various development phases at White Sands Test Facility (WSTF). Systems that produce redundant information would be eliminated, and systems that provide insufficient information would be improved. The result would be the development of a series of tests that provide comprehensive information about the compatibility of a given metal in high pressure oxygen. Several different basic ignition sources such as particle impact, heat due to friction, adiabatic compression, etc., would be used. Approximately 15 metallics would be used to evaluate the test methods under consideration. The selected metallics would range from those which are very reactive in oxygen to those that are very nonreactive in oxygen. At the end of the test program a NASA Technical Memorandum would be generated. Test systems with standardized procedures provided would be capable and ready to screen and qualify metallics for use in high pressure oxygen.

W84-70324 **323-53-04**
Langley Research Center, Hampton, Va.
NASA HANDBOOK, NHB 1700.1(V3) 'SYSTEM SAFETY HANDBOOK'
Felix P. Crommie 804-865-2528

The NASA Handbook, NHB 1700.1(V3), 'System Safety Handbook' will be revised in its entirety to update agency policy and requirements for effective and efficient implementation of System Safety to a broad spectrum of programs and to provide guidelines and descriptions of analytical techniques used to perform risk assessments of Flight Systems, Test and Research Facilities, Support Equipment and Operational Software. This effort will be accomplished through a contract with a company that has specialized experience and expertise in the performance of system safety analyses on both ground based and flight system hardware. An Ad Hoc Committee, comprised of representatives from NASA Centers, will be established to provide technical guidance and review of drafts during incremental phases of the Handbook development. Selected members of this Committee will be assigned 'Task Leader' responsibility for developing, with the contractor, specific sections of the Handbook.

W84-70325 **323-53-05**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF GUIDELINES FOR QUALIFICATION AND LOT ACCEPTANCE TEST FOR PYROTECHNIC DEVICES USING THE NSI.
Michael P. Zydowicz 213-354-4142

The objective of this RTOP is to develop a guideline document which would assist users in structuring NASA standard initiator (NSI) initiated pyrotechnic device qualification and lot acceptance test programs. When necessary, these tests would be used to demonstrate the capability of pyrotechnic devices as well as NSI to withstand environments beyond those required by this existing NSI specification. The use of such a document would result in more consistent testing of the NSI/pyrotechnic device and thus provide a greater confidence level in flight success as well as the safety of the flight hardware, shuttle crew and launch vehicle. The approach would be to survey NSI vendors and users to obtain information regarding test history, background, device design, and use and environment. This data would be analyzed and used to determine the feasibility of a guideline document. Preparation of such a document would follow.

W84-70326 **323-53-07**
Marshall Space Flight Center, Huntsville, Ala.
NASA HANDBOOK, NHB XXXX, 'FACILITIES INTEGRITY HANDBOOK'
David C. Harris 205-453-1360

A new handbook will be developed to provide a comprehensive methodology for application of assurance requirements to NASA facilities during all phases of their life cycle. The handbook will address safety, reliability, quality, maintainability, and other features essential to facility integrity (including configuration control and use of procedures for hazardous operations), with emphasis on definition and management of these features. The handbook will provide a rationale for the selection of the assurance efforts appropriate to the scale, criticality, and hazard level of a given facility. It will incorporate into existing policy those methods which have proven successful within the NASA system, such as the operational readiness inspection process, to develop an integrated agency position. The objective will be attained in three steps: (1) preparation of a draft outline of the contents of the handbook; (2) constructive review of the outline over a limited number of iterations by a steering group composed of representative of each center (membership will be selected to provide a broad spectrum of knowledge and experience); and (3) the development of the handbook. The third step will be accomplished via the procurement of a contractor which will prepare the initial draft, incorporate revisions resulting from a limited number of reviews by the steering group, and identify any incompatibilities with existing policy documents at the same or higher level of authority.

W84-70327 **323-53-08**
John F. Kennedy Space Center, Cocoa Beach, Fla.
NASA STANDARD INITIATOR (NSI) SIMULATOR
F. Blum 305-867-4493

Continuous passive monitoring of ordnance electrical circuits, detection of extraneous energy on an ordnance circuit, and recording the time of event and the magnitude of the event are necessary to assure the integrity of the ordnance system. Because this type activity, as performed today on other missile programs, is inherent with cumbersome equipment (i.e., cable harnesses, power supplies, computers, electrical support equipment), there exists a need to develop a small, self-contained simulator that will perform as many (hopefully all) of the above-listed desirable functions as possible. The development process should concentrate on using techniques similar to those used in wristwatch design. The results should produce a useful NSI simulator that would be connected to the STS ordnance circuits during hangar/buildup/test periods. The simulator must be capable of performing a PIC load test, PIC resistance test, and record the time, magnitude, and duration of any extraneous transient that may inadvertently appear on the firing lines.

W84-70328 **323-53-51**
Goddard Space Flight Center, Greenbelt, Md.
AIRCRAFT MISFUELING DETECTION PROGRAM
J. Holland Scott, Jr. 804-824-3411

The research conducted under this RTOP will be directed toward the development of a simple test (and equipment to conduct such a test) to allow a pilot to positively identify the fuel in his aircraft prior to its operation. The work is dependent upon determination of a unique property or characteristic of different aircraft fuels.

W84-70329 **323-53-61**
Lewis Research Center, Cleveland, Ohio.
LIFE SAFETY EVALUATION SYSTEM FOR NASA OCCUPANCIES
Jack R. Colegrove 216-433-4000

The objectives of this program are to develop guidelines to be used in designing and evaluating equivalent methods of attaining compliance with the Life Safety Code as prescribed by the National Fire Protection Association, and to develop a methodology to assign numerical values to the guideline elements, thereby permitting quantitative comparisons of equivalency proposals versus the prescription requirements of the Life Safety Code. The guidelines will take into account the general fire protection elements presently existing within the Agency such as types of building construction, occupancies, personnel stability, fire detection/suppression systems and fire department response. Other concepts

of fire protection will also be utilized such as compartmentalization, smoke control and new construction materials. These variables will each be defined as viable options to prescription requirements, both in conjunction with each other or with other specific conditions. Use of the quantitative system would greatly simplify design evaluations involving Life Safety modifications to NASA facilities.

W84-70330 **323-53-71**
Langley Research Center, Hampton, Va.
FATIGUE STUDY OF WELDS CONTAINING UNACCEPTABLE INDICATIONS
C. Michael Hudson 804-865-4631

The NASA-Langley pressure-systems recertification program identified large numbers of welds which are code-unacceptable. These welds have survived thirty-to-forty years of service without exhibiting fatigue damage. Thus, the national consensus codes may be excessively conservative in their evaluations of weld quality. This investigation will evaluate the fatigue resistance of unacceptable welds, and establish more realistic acceptance criteria for such welds. It will be conducted in two phases. First, a literature search will be conducted to gather all of the available data on fatigue of unacceptable welds. These data will be compiled into S-N curves for various types of unacceptable welds. Second, a number of the unacceptable welds identified in LaRC's Recert Program will be removed from service and fatigue tested to failure. The results of these tests will be compared with the S-N curves to determine the degree of correlation. A high degree of correlation will indicate that the S-N curves can be used to predict the fatigue behavior of code-unacceptable welds.

W84-70331 **323-53-80**
John F. Kennedy Space Center, Cocoa Beach, Fla.
MISHAP REPORTING AND CORRECTIVE ACTION SYSTEM (MR-CAS)
J. Wortman 305-867-4888

KSC implemented a Mishap Reporting and Corrective Action System which is effective in administering the mishaps occurring at the Center. The system provides a closed loop method for tracking all mishaps and requires a formal closure. A 'Lessons Learned Bulletin' is published and disseminated for those mishaps having a possible application or being of general interest to other NASA Centers. The objectives of the proposed effort are: (1) provide Headquarters with a management information system that can be used on a real-time basis to analyze mishaps and causes and include countermeasure programs as necessary; (2) assist other NASA Centers in developing a similar/compatible system; and (3) assist the NASA-Safety Division directly or through their contractor in establishing a NASA-Wide Mishap Reporting and Corrective Action System.

OFFICE OF SPACE SCIENCE AND APPLICATIONS

Global Weather Research Program

W84-70332 **146-60-00**
Goddard Space Flight Center, Greenbelt, Md.
METEOROLOGICAL SATELLITE DATA RESEARCH
Ernest A. Neil 301-344-6291

The objectives are to exploit satellite observations of the atmosphere to initialize, verify and improve models, diagnose atmospheric processes, assess the impact of satellite data on forecast accuracy, and increase understanding of atmospheric behavior. The approach is to: (1) diagnose the genesis, development, maturation and decay of organized large-scale weather systems; (2) conduct numerical model experiments to assess the usefulness of satellite observing systems; (3) initialize, update and assess the performance of various predictive models; and (4) improve the resolution and realism of general circulation models.

W84-70333 **146-61-00**
Marshall Space Flight Center, Huntsville, Ala.
SATELLITE DATA RESEARCH AND APPLICATIONS
W. W. Vaughan 205-453-3100

This RTOP will contribute to the NASA Global Scale Processes Research program objectives by performing diagnostic and theoretical studies of global-scale atmospheric systems to: (1) develop new and improved spaceborne atmospheric sensing techniques; (2) develop new techniques to extract information from and more fully utilize existing and planned spaceborne atmospheric sensing systems; and (3) contribute to the development of our understanding of global scale processes. Diagnostic studies with satellite and ground-based data sets will be conducted, guided by theoretical studies to understand the role of latent heat release in the dynamics of cyclones. Global atmospheric processes will be examined to gain improved understanding of the scales of motion; and techniques will be developed for including satellite data in diagnostic procedures.

W84-70334 **146-64-00**
Goddard Space Flight Center, Greenbelt, Md.
GLOBAL WEATHER EXPERIMENT DATA PROCESSING AND RESEARCH
Ernest A. Neil 301-344-6291

This RTOP supports research investigations by the Academic community and NASA investigators utilizing the FGGE data base; provides advanced computational techniques and equipment to support such research; and investigates new data sources for incorporation into global circulation models. Support of outside investigators' proposals for research utilizing the FGGE Data Base will continue through Peer Review of submitted proposals. The modeling and simulation computer facility will continue to be operated in support of University and in-house atmospheric research efforts. A new high speed vector processor will be procured, checked out, and operated in support of University and NASA atmospheric research programs. New and novel data processing techniques and advanced data sources will be investigated for applicability to Global Circulation Models.

W84-70335 **146-65-00**
Goddard Space Flight Center, Greenbelt, Md.
METEOROLOGICAL PARAMETER EXTRACTION
Ernest A. Neil 301-344-6291

This RTOP will develop new and improved techniques for retrieving useful parameters from satellite-measured radiances and interpret these retrievals to provide information on the state and motion of the atmosphere. Investigations and case studies will be conducted to develop interpretative information and establish relationships between satellite radiances and atmospheric processes. Advanced algorithms will be developed to perform the required transformations. Methods to determine temperature, moisture, wind and precipitation from measurements of various portions of the electromagnetic spectrum will be studied.

W84-70336 **146-66-01**
Jet Propulsion Laboratory, Pasadena, Calif.
NUMERICAL ANALYSIS OF REMOTE SENSING DATA
M. T. Chahine 213-354-2433

The main objective of the proposed investigation is to develop rapid retrieval algorithms for accurate interpretation of remote sounding radiance data measured by the various NASA and NOAA weather satellites. The components of the retrieval algorithms will consist of individual numerical methods dealing with: (1) application of analytical techniques to separate the effects of clouds from the radiance data measured in the presence of partial cloud covers; (2) development of a three-dimensional quality control approach to filter out spurious temperature profiles; (3) adaptation of the resulting temperature profiles to the requirements of the GLAS-GCM to demonstrate the impact of remote sounding data on weather forecasting; (4) retrieval of accurate sea-surface temperature using the 3.7 micrometer window; (5) derivation of three-dimensional global maps of the distribution of the amounts and heights of clouds; (6) improving the accuracy of computed

atmospheric transmission functions needed for interpretation, using spectral data measured by the JPL high speed interferometers; and (7) investigating an approach to derive air-sea surface temperature differences at the surface, using data from the HIRS 2 instrument; and (8) produce global images of weather and climate parameters obtained under this study.

W84-70337 **146-70-00**
Goddard Space Flight Center, Greenbelt, Md.
METEOROLOGICAL OBSERVING SYSTEM DEVELOPMENT
S. H. Melfi 301-344-6348

The objectives are to develop new and improved spaceborne remote sensing systems in support of the NASA Global Weather Program, and to establish improved data processing and retrieval techniques to provide for more accurate understanding of processes which influence the state and behavior of the atmosphere. Theory, laboratory measurements, and field experiments will be used to define, develop, and evaluate new and improved remote sensing techniques to observe profiles of atmospheric temperature, moisture, and pressure; precipitation; surface properties; and atmospheric radiative properties. Infrared, visible, microwave, and passive modes will be studied. Evaluation, in cooperation with other scientists, will be performed to assess improvement in weather forecasting.

W84-70338 **146-71-00**
Wallops Flight Center, Wallops Island, Va.
VERIFICATION AND ANALYSIS OF SATELLITE DERIVED PRODUCTIONS
F. J. Schmidlin 804-824-3411

Meteorological rawinsonde and rocketsonde measurements will be provided for comparison, verification, and calibration of the Operational Environmental Satellite Instruments (i.e., NOAA-7). All available rocketsonde data will be used to compare, analyze, and interpret the measurements, including assessing the reliability and precision of the in situ instruments. Methods to enhance the applicability of TOVS data will be demonstrated and meteorological rocketsonde data will be provided in support of space shuttle reentry analysis. Unique rawinsonde and rocketsonde measurements obtained at WFF between 1980 and 1984 during satellite overpass are to be used as a control on comparisons of in situ/satellite data obtained at the MRN rocketsonde sites. Argentina, Brazil, Norway, Sweden and USSR data, as available, will provide additional data covering wider geographic distribution. Statistical analysis of measurement pairs will continue. Data obtained during the 30-day series of February/March 1982 will be finalized to illustrate the comparability of satellite measured winds with in situ measured winds.

W84-70339 **146-72-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE PRESSURE SOUNDER
D. A. Flower 213-354-4151

This RTOP supports the completion of the second phase of the microwave pressure sounder (MPS) research program, the objective of which is to develop an instrument for the remote measurement of atmospheric pressure at the Earth's surface. Surface pressure is an important meteorological parameter but no method at present exists for its remote measurement. Extensive design studies have shown that differential absorption measurements in the wings of the 60 GHz oxygen absorption band are potentially capable of providing surface pressure observations with the accuracy and coverage suited to applications in global weather research and operational weather forecasting. The specific objectives of this phase of the investigation are: (1) characterization of the performance of an aircraft version of the MPS; (2) modification of the instrument to obtain optimum performance; and (3) verification of the pressure measuring concept using data from test flights of the instrument on the NASA CV-990 aircraft. The approach will be to use data from test flights previously carried out with the instrument on the NASA CV-990 aircraft, together with the results of laboratory tests to characterize the instrumental performance. These tests will be used to define necessary modifications to the instrument so that its long term stability is optimized. The modified instrument will be further tested in the laboratory and then used in a new series of test flights on the CV-990 aircraft. Data from these flights will be analyzed and the results applied to previously developed optimization procedures for the selection of operating frequencies of a satellite MPS.

W84-70340 **146-72-02**
Jet Propulsion Laboratory, Pasadena, Calif.
GLOBAL WEATHER RESEARCH--ADVANCED MOISTURE AND TEMPERATURE SOUNDER (AMTS)
M. T. Chahine 213-354-2433

The ultimate objective of this effort is to develop an infrared Advanced Moisture and Temperature Sounder (AMTS) which meets the requirements of the numerical weather prediction models of the late 1980's. These models require global atmospheric temperature profiles with an accuracy of 1K and with a vertical resolution comparable to that of radiosondes. This accuracy and vertical resolution requirement, which is not satisfied by current sounders, is achievable with the AMTS concept by careful choice of narrow band infrared channels utilizing the dependence of the absorption coefficients on pressure and temperature. Improvements in the vertical resolution of tropospheric temperature profiles to meet numerical weather prediction requirements are obtained from measurements with a resolution of 2/cm in high J-lines of the R-branch of the 4.3 micrometer CO2 band. A complementary set of 15 micrometers channels with a spectral resolution of 0.5/cm is used to sound the upper troposphere and stratosphere. Elimination of the effects of clouds is accomplished by taking simultaneous measurements in the 4.3 and 15 micrometers bands. During the past years, designs were developed for a 'stand-alone' all infrared AMTS for a Low-Earth-Orbiter (LEO). During FY 83, a summary AMTS study report was written and the interaction between hardware capability, end user need, and ground data processing was studied. During FY 84, effort will be concentrated on an AMTS system study, that is the interaction between hardware capability, end-user need and ground-data processing, envisioned by the user or necessitated by hardware or mission constraints.

W84-70341 **146-72-04**
Jet Propulsion Laboratory, Pasadena, Calif.
TROPOSPHERIC WIND MEASUREMENT ASSESSMENT
R. T. Menzies 213-354-3787

The objective of this program is to evaluate certain aspects of an active laser technique for global measurement of tropospheric wind fields. This technique, based on long range Doppler lidar using pulsed lasers, has the potential for providing global wind data from an orbiting platform. Several types of remote measurement of atmospheric wind velocities have been analyzed, e.g., passive microwave, millimeter wave, infrared radiometry, and active visible and infrared range-gated lidar, with the results indicating that the Doppler lidar technique (using CO2 lasers or others with similar characterstics), is the superior technique for tropospheric wind field measurements. During FY-84, the work will continue on an experimental study of vertical profiles of atmospheric backscatter at various CO2 laser wavelengths in the 9-11 micrometer region. This study will be conducted using an existing TEA CO2 lidar facility, employing a single longitudinal-mode injection-controlled TEA laser transmitter, and a heterodyne receiver. A mini-TEA laser will be used in a ring laser configuration to study its properties when injection locking is employed, and design of an interface between this type of laser and an airborne optical system will be performed in preparation for future measurements of aerosol backscatter at various latitudes.

W84-70342 **146-72-05**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED MICROWAVE SENSING OF METEOROLOGICAL PARAMETERS
R. K. Kakar 213-354-7748

The objective of the proposed research is to specify a Future Operational Microwave Sounder (FOMS) system that will serve as a successor to the currently operational Microwave Sounding Unit

(MSU). The primary objective for the FOMS system will be to provide global data on temperature and water vapor profiles for synoptic weather forecasting. Precipitation intensity and distribution, integrated water content, and cloud liquid water will also be measured. The previously proposed advanced microwave sounding unit will serve as a baseline for the specification of FOMS. Theoretical and experimental studies will be performed to optimize the capability of the FOMS system. The necessary measurement program will be carried out with the suitably modified airborne advanced microwave moisture sounder developed by the Georgia Institute of Technology. Some of these measurements will be carried out in collaboration with T. T. Wilheit of NASA/GSFC.

W84-70343 **146-72-06**
Jet Propulsion Laboratory, Pasadena, Calif.
ATMOSPHERIC PARAMETER MAPPING
R. J. Blackwell 213-354-5677
(146-66-01)

This work addresses the problem of producing time-lapse imagery of global atmospheric parameters from the high resolution infrared radiation sounder (HIRS-2) and the Microwave Sounding Unit (MSU) sensors on the NOAA series satellites. The information will be produced in a series of motion picture film strips and high resolution images. Software, previously developed and tested for conceptual purposes, will be improved to increase computing speed. Prototype mapping procedures used to transform the HIRS-2 and MSU data into map form will be improved and standardized to facilitate map production. Specialized hardware for recording digital imagery into color film will be secured to assure high resolution imagery and high volume output.

Upper Atmospheric Research Program

W84-70344 **147-11-00**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - FIELD MEASUREMENTS
William S. Heaps 301-344-5106

To determine specific local chemical and physical interactions in the atmosphere using coordinated in-situ measurement campaigns from balloon platforms, specifically with respect to the OH radical, and related species. (1) To develop a balloon borne LIDAR system for the measurement of trace species, especially OH and ozone. (2) The direct measurement of photolysis rates of importance in the atmosphere. (3) Develop a balloon-borne cryosampling system for the detection and measurement of low molecular weight hydrocarbons.

W84-70345 **147-11-04**
Jet Propulsion Laboratory, Pasadena, Calif.
STRATOSPHERIC RESEARCH, BALLOON LASER IN-SITU SENSOR
C. R. Webster 213-354-7478

The Balloon Laser In-Situ Sensor (BLISS) task has as its primary objective the collection of reliable data on the concentrations, distributions, and variabilities of the minor and trace species in the stratosphere. These data are to be used by modelers and dynamicists to assess and predict the effects of change in the chemical content of the upper atmosphere due to anthropogenic activity. The BLISS instrument uses Tunable Diode Lasers (TDLs) to measure the absorption due to selected species between the balloon gondola and a lowered retroreflector which defines a 1-km absorption path. The TDL beam in use is stabilized onto the lowered retroreflector by use of an optical tracking system. Several species can be measured simultaneously to the 0.1 ppbv level in sensitivity, throughout a diurnal cycle, and with the additional possibility of altitude profiling.

W84-70346 **147-11-05**
Lyndon B. Johnson Space Center, Houston, Tex.
IN-SITU MEASUREMENTS OF STRATOSPHERIC OZONE
Donald E. Robbins 713-483-2956

The object of this RTOP is to perform an experiment to measure ozone in-situ with highest accuracy to aid in improving those measurements and testing those models that are used in assessing the effect of man-made chemical compounds upon stratospheric ozone. An UV photoabsorption technique will be used to measure ozone onboard multi-sensor balloon platforms. Results will be intercompared with those of other techniques. Ozone and other atmospheric species involved in ozone chemistry will be simultaneously measured. Results will be compared with models that use state-of-the-art reaction rates and full complement of species believed to be involved in ozone chemistry.

W84-70347 **147-12-00**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - FIELD MEASUREMENTS
J. E. Mentall 301-344-8959

The objectives are to: (1) determine the specific local chemical and physical interactions in the atmosphere by a combination of theoretical studies and coordinated in-situ measurement campaigns from rocket and balloon platforms; (2) investigate the variations and perturbations of the chemical and physical state of the atmosphere, i.e., variations with altitude, solar conditions, season, latitude, and perturbations from volcanoes, tropical storms, industrial and agricultural activity; and (3) develop and calibrate selected instruments for local and remote investigations of the atmosphere. A balloon-borne Michelson interferometer will be developed to measure the concentrations and diurnal variations of trace stratospheric species. A pointed spectrometer system to measure the solar photon flux within the stratosphere will also be developed. Multi-instrument, coordinated measurements will be performed on minor species in the stratosphere. One dimensional photochemical models will be to compare experimental results with theoretical predictions.

W84-70348 **147-12-05**
Jet Propulsion Laboratory, Pasadena, Calif.
STRATOSPHERIC FOURIER SPECTROSCOPY AT NEAR AND MID IR WAVELENGTHS
C. B. Farmer 213-354-2039

The primary objective of this task is to obtain reliable data on the concentration and distribution of minor and trace species in the Earth's upper atmosphere. These data are provided for use by modelers and dynamicists to assess and predict the effects of changes in the chemical contents of the stratosphere due to man's activities. The emphasis of this task is placed on the simultaneous determination of profiles of a large number of related families of photochemical species with sufficient accuracy to permit seasonal variations to be detected. Compositional data are determined from infrared absorption spectra in the 2.5 to 16 micrometer region at a resolution of 0.01/cm obtained by observing the Sun through long stratospheric paths at sunset or sunrise from high altitude balloons. The instrument is a new continuous scan Michelson interferometer which can obtain data in 80 second time intervals, fast enough to result in a vertical height discrimination of better than 2 km. The instrument's throughput is such as to produce spectra which have signal to noise ratios in excess of 200:1 throughout.

W84-70349 **147-12-06**
Jet Propulsion Laboratory, Pasadena, Calif.
MILLIMETER AND SUBMILLIMETER RADIOMETRY
J. W. Waters 213-354-3025

The objective of this program is to improve understanding of Earth's upper atmosphere by microwave measurement techniques at millimeter and submillimeter wavelength. Well founded concerns that man's technological activities may perturb upper atmospheric balances, particularly those maintaining stratospheric ozone, justify this objective. The approach is to first determine which measurements are needed for atmospheric research and perform calculations to define which subset of these can be usefully performed by microwave techniques. A field program is then established for those measurements of sufficient use. The field program may involve instrument development or improvement. One important

goal of this program is to determine both the capabilities and limitations of microwave techniques so they can be used efficiently in NASA's overall Upper Atmosphere Research Program. The plan of this research program for the current year is to improve the sensitivity of the existing JPL Balloon Microwave Limb Sounder (BMLS) and use it in a NASA-coordinated measurement program to improve understanding of how chlorine from industrial sources might deplete stratospheric ozone. The BMLS operates simultaneously in three spectral bands near 205 GHz to measure thermal emission from O3, ClO, and tentatively, H2O2.

W84-70350 **147-14-01**
Ames Research Center, Moffett Field, Calif.
STUDY OF STRATOSPHERIC-TROPOSPHERIC EXCHANGE
P. Russell 415-965-5404
(147-14-03; 147-14-04; 147-14-08)

The overall goal of this program is to advance understanding of the mechanisms that transport gases and particles between the stratosphere and troposphere, and to quantify the rates of exchange on local and global scales. Specific aims are to determine whether cumulus towers and their cirrus anvils are a net source or sink of stratospheric water vapor, and understand the detailed mechanism; and to quantify the mass exchanged across the cloud-free tropopause, and determine transfer times. A working group formulates investigation guidelines. With this guidance missions are planned, organized, and conducted using suitable aircraft and satellite platforms. Results are reviewed and used by the working group, made available to other scientists, analyzed, and published. Examples of missions are U-2 studies of midlatitude tropopause folds and ER-2 studies of cirrus anvils. Publications include special issues of journals and NASA TMXs.

W84-70351 **147-14-03**
Ames Research Center, Moffett Field, Calif.
U-2/ER-2 METEOROLOGICAL MEASUREMENT SYSTEM (MMS) DEVELOPMENT
K. R. Chan 415-965-6263
(176-20-01)

The objectives are to develop special instrumentation and to equip the U-2/ER-2 aircraft with in-situ, fast-response and high-resolution thermodynamics and air motion measurement capabilities. These measurement capabilities are essential to the Stratosphere/Troposphere Exchange missions under the Upper Atmosphere Research Program. The approach is (1) to use a conventional nose-boom air motion sensor subsystem; (2) to upgrade the existing inertial navigation unit into a high-resolution subsystem; and (3) to develop a microprocessor-controlled data acquisition subsystem for flexibility and high-storage capacity. The three subsystems will be integrated, tested, and calibrated for participation in the Stratosphere-Troposphere Exchange and Climate Programs.

W84-70352 **147-14-04**
Ames Research Center, Moffett Field, Calif.
ER-2 EXPERIMENT INTEGRATION
R. Craig 415-965-5695
(672-21-03)

The goals of this program are to: insure the experiments are successfully integrated onto appropriate aircraft in time to participate in scheduled missions and pre-mission test flights; (2) provide flight support; and (3) provide auxiliary experiments as required to meet the science objectives of the missions. Aircraft space allocations are developed in conjunction with experimenters, advisory groups, and the integration contractor. Integration cost estimates are obtained from the aircraft integration contractor in consultating with the experimenter. Integration is funded and progress and completion are monitored. Liaison between experimenter, integraters, and flight personnel is maintained before, during, and after flights.

W84-70353 **147-14-07**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE TEMPERATURE PROFILER FOR THE U-2 AND ER-2 AIRCRAFT FOR SUPPORT OF STRATOSPHERIC/ TROPOSPHERIC EXCHANGE
B. L. Gary 213-354-3198
(505-44-15)

The proposed task is for construction and use of an airborne instrument that will provide 'altitude temperature profile' information during a multi-disciplinary investigation of stratospheric/ tropospheric exchange processes. The 'profiler' data will be used to measure the 'potential vorticity' of the layer of air sampled by the aircraft. Potential vorticity will then be used by other investigators as a tracer of stratospheric air in the study of transport processes. A passive microwave radiometer will be constructed for installation in either of the U-2 or ER-2 aircraft operated by the Ames Research Center. The radiometer will execute elevation scans every few seconds. Sky brightness temperature versus elevation angle data will be used to produce temperature versus altitude plots. Lapse rate information will be derived from this data, which will be combined with horizontal wind shear information (from the inertial navigation system) to obtain potential vorticity. Potential vorticity is a conservative property of air parcels, and can therefore be used as a tracer for the exchange of stratospheric air into the troposphere, and visa versa. The microwave sensor will be an improved version of a similar sensor that has been constructed and installed in the NASA C-141 at the Ames Research Center. The C-141 sensor is being used for the study of 'clear air turbulence'. The new sensor will operate at two frequencies, and should provide useful temperature profile data for a 7,000-foot altitude region during flight at altitudes of from 35,000 feet to 70,000 feet.

W84-70354 **147-14-08**
Ames Research Center, Moffett Field, Calif.
STRATOSPHERE-TROPOSPHERE EXCHANGE WORKSHOPS
K. R. Chan 415-965-6263
(147-14-01)

The objective is to define scientific rationale, to select critical experiments, to plan coordinated missions, and to assess the progress of the Stratosphere-Troposphere Exchange Program. The approach is to hold workshops involving program and project managers, program and project scientists, technical experts, consultants, and investigators at appropriate intervals.

W84-70355 **147-14-10**
Ames Research Center, Moffett Field, Calif.
TRACER STUDIES IN THE STRATOSPHERE
J. Vedder 415-965-6259
(147-14-03; 147-14-04; 147-31-01)

The objective of this research is to characterize the distribution of trace gas constituents in the Earth's stratosphere. Focus will be centered on those trace species of interest from both a photochemical standpoint as well as from a transport/exchange process viewpoint. Knowledge of the concentration and distribution of these gases will permit a better understanding of the photochemical processes which occur in the upper atmosphere. Correlation of the trace gas data with the extensive meteorological data sets obtained will yield a better understanding of the air mass motions involved in transporting the gases into and out of the stratosphere. An airborne gas chromatograph, AGC, will be used for in-flight gas analysis on the U-2. New detectors for hydrocarbon analysis are currently being evaluated for use on the AGC. In addition, air samples, both whole air and cryogenically enriched, will be collected on the aircraft and returned to the laboratory for subsequent analyses. A refined whole air sampling capability is under development whereby samples pressurized by a special metal bellows pump will be collected for the methane and non-methane hydrocarbon analysis. The vertical distribution data collected on the trace gases measured in this program will be correlated with the other experimental data obtained on each mission as well as with the meteorological data sets gathered as

part of each experiment. The trace gas data will also serve as input to theoretical models.

W84-70356 **147-15-00**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR FLUX IN UPPER ATMOSPHERE
J. E. Mentall 301-344-8959

This RTOP aims to determine the transmission of the Earth's atmosphere in the molecular oxygen Schumann-Runge Bands. A spectrometer pointed at the Sun from a high altitude parachute is used to measure the transmitted photon flux in the wavelength region 180-300 nm as a function of altitude. The transmitted photon flux is compared with the predicted flux using absorption cross sections measured in the laboratory. This comparison provides a sensitive test of the accuracy of the absorption cross sections when the optical depth is greater than one.

W84-70357 **147-16-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTI-SENSOR BALLOON MEASUREMENTS
W. T. Huntress 213-354-8275
(147-12-05; 147-12-06; 147-12-08)

A continuing series of stratospheric balloon flights is conducted to measure the abundance and altitude distribution of key chemical constituents in the upper atmosphere. A modular gondola system is used to carry a multi-instrumented package consisting of several JPL remote sensing instruments, or instruments from other institutions in the U.S. and abroad, configured for a particular scientific purpose for any one flight. Data are obtained on the altitude profiles for a number of chemically coupled species all at the same time and in the same air mass for instrument intercomparison purposes and for the validation of atmospheric chemical models.

W84-70358 **147-18-02**
Jet Propulsion Laboratory, Pasadena, Calif.
GAS CORRELATION WIND SENSORS
D. J. McCleese 213-354-2317

The objective of this task is the development of a measurement technique for remote sensing of stratospheric and mesospheric winds from spacecraft. The approach is through the continued laboratory development and test of a gas correlation spectroradiometer. This instrument measures the wind induced Doppler shift in atmospheric thermal emission spectra of selected molecular species (e.g., N2O and CO2). Previous numerical and laboratory studies of this technique conducted at JPL indicate that wind measurements can be made in the 20 to 120 km altitude interval with an accuracy of better than 5 m/s. The gas correlation wind sensor is also capable of making simultaneous measurements of atmospheric temperature and trace species abundance profiles in the upper atmosphere. These capabilities will also be developed in the laboratory.

W84-70359 **147-21-00**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - REACTION RATE MEASUREMENTS
L. J. Stief 301-344-7529

This RTOP proposes to measure chemical kinetic rate coefficients of importance to the stratosphere and mesosphere. The laboratory effort in chemical kinetics uses existing equipment of unique capability for the purpose of measuring absolute rate constants of reactions of importance in current models of the stratosphere. Rate constants of atom-molecule and radical-molecule reactions are measured as a function of temperature and pressure using the technique of flash photolysis-resonance fluorescence. A new research direction, radical-atom and radical-radical reactions, will necessitate the construction of a mass spectrometer system for incorporation into our dischange flow apparatus. Intra-cavity laser absorption will be examined as a complement to both fluorescence and mass spectrometric detection.

W84-70360 **147-21-03**
Jet Propulsion Laboratory, Pasadena, Calif.
CHEMICAL KINETICS OF THE UPPER ATMOSPHERE
W. B. DeMore 213-354-2436

To obtain direct measurements of rate constants and temperature dependences for reactions of HO(x), NO(x), ClO(x), BrO(x), and RO(x) in stratospheric chemistry, and to develop techniques for laboratory study of relevant transient species.

W84-70361 **147-21-09**
Jet Propulsion Laboratory, Pasadena, Calif.
BIOGENIC ORIGIN OF METHYL CHLORIDE
M. N. Dastoor 213-354-7429
(199-30-34)

The role of the biota in the maintenance and modulation of the major constituents of the atmosphere (i.e., N2, O2, CO2) is well established. In contrast, the biotic interactions involving trace atmospheric constituents are unknown. Of particular importance, is the atmospheric ozone layer. The objective of this proposal is to perform a study to evaluate the contribution of certain marine algae (i.e., Macrocystis pyrifera) which evidence suggests should be involved in the production of methyl chloride. Marine macroalgae may produce methyl chloride by direct biosynthesis, by producing an intermediate compound which is chemically converted to methyl chloride in seawater or by supplying, after death, certain metabolites for microbial degradation. An understanding of the natural production of methyl chloride is required to construct a suitable atmospheric halogen budget and to determine its contribution to atmospheric ozone destruction. The marine algae species which are responsible for methyl halide production will be identified. If an indirect mechanism of methyl halide production is required, the possibility that non-photosynthetic and/or methanogenic bacteria may utilize certain marine algae to methyl halides will be investigated. The production of methyl halides will be quantified and a correct atmospheric halogen budget based on the results will be constructed. Laboratory culturing of marine algae and methanogenic bacteria, and quantitative chemical analysis will be employed. Quantitative field measurements of marine kelp bed (Point Loma, CA) known to have elevated levels of methyl chloride will also be conducted.

W84-70362 **147-22-01**
Jet Propulsion Laboratory, Pasadena, Calif.
PHOTOCHEMISTRY OF THE UPPER ATMOSPHERE
W. B. DeMore 213-354-2436

The objective is to conduct laboratory studies of stratospheric photochemistry, including photolytic quantum yields, reaction rates and mechanisms, product distributions, and absorption cross sections.

W84-70363 **147-22-02**
Jet Propulsion Laboratory, Pasadena, Calif.
ATMOSPHERIC PHOTOCHEMISTRY
M. J. Molina 213-354-5752
(147-20-01)

Laboratory studies will be conducted to elucidate the photchemistry of the atmosphere. Measurements will include reaction rate constants of the hydroxyl radical with various polar molecules over an extended pressure and temperature range; absorption cross sections as a function of wavelength and temperature; and FTIR spectra of reaction intermediates.

W84-70364 **147-23-00**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - LABORATORY MEASUREMENTS
T. J. McGee 301-344-5645

(1) To support ongoing LIDAR experiments. (2) To perform laboratory studies to test the feasibility of measurements of additional species. (3) To test and calibrate new instruments. (4) Measurement of UV absorption cross sections of importance in atmospheric photochemistry. To measure spectroscopic parameters of important atmospheric constituents in all regions of

the spectrum from the VUV to submillimeter waves. Studies will be performed in both absorption and emission.

W84-70365 **147-23-01**
Ames Research Center, Moffett Field, Calif.
QUANTITATIVE INFRARED SPECTROSCOPY OF MINOR CONSTITUENTS OF THE EARTH'S STRATOSPHERE
Charles Chackerian, Jr. 415-965-6300

Remote detection and measurement of stratospheric minor constituent species via spectroscopic techniques is being routinely employed to develop a better understanding of this portion of our atmosphere and man's effect upon it. Proper interpretation of these measurements relies strongly on having the correct molecular parameters. The objective of this work is to obtain laboratory measurements of basic molecular parameters, such as rotational line intensities and half-widths, absorption band intensities, vibrational and rotational constants, vibration-rotation interaction constants, and line position measurements including pressure induced shifts. The determination of these parameters, and their dependence on pressure and temperature, will be obtained by using long path gas cells, cooled cells, high resolution interferometers, and tunable diode laser spectrometers.

W84-70366 **147-23-08**
Jet Propulsion Laboratory, Pasadena, Calif.
IR LABORATORY SPECTROSCOPY
R. A. Toth 213-354-2140

The program involves the acquisition of laboratory spectra and the analysis of molecular spectral parameters which are required for the interpretation of data from stratospheric measurements. The laboratory spectral measurements will be conducted specifically in support of the JPL infrared interferometers. These instruments have requirements relative to spectral regions of operation, spectral resolution, and molecules for which they are best suited. Emphasis is placed on accuracy of line frequency, line width, and line strength measurement so in order to take full advantage of spectroscopic techniques for quantitative atmospheric species measurements. A large portion of the spectral data will also be of value to other groups who use spectroscopic instruments for atmospheric measurements.

W84-70367 **147-23-09**
Jet Propulsion Laboratory, Pasadena, Calif.
LASER LABORATORY SPECTROSCOPY
C. R. Webster 213-354-7478

The laser laboratory spectroscopy program involves the acquisition and analysis of molecular spectral parameters which are required for the interpretation of data from laser stratospheric measurements, specifically by the BLISS and LHR infrared laser instruments. Line positions, absorption strengths, and air broadening coefficients are the spectral parameters measured. New spectroscopic techniques by which laser wavelengths may be directly calibrated in flight are also investigated.

W84-70368 **147-23-10**
Jet Propulsion Laboratory, Pasadena, Calif.
MILLIMETER/SUBMILLIMETER LABORATORY SPECTROSCOPY
E. A. Cohen 213-354-4701

A program of laboratory studies related to stratospheric research will be conducted in millimeter and submillimeter spectroscopy. The program involves the acquisition and analysis of molecular spectral parameters which are required for the interpretation of data from stratospheric measurements. The laboratory spectral measurements will be conducted specifically in support of the JPL millimeter radiometer instruments. Emphasis is placed on accuracy of line frequency, line width, and transition movement measurements, in order to take full advantage of spectroscopic techniques for quantitative atmospheric species measurements. A large portion of the spectral data will also be of value to other groups who use spectroscopic instruments for atmospheric measurements.

W84-70369 **147-32-02**
Ames Research Center, Moffett Field, Calif.
STRATOSPHERIC DYNAMICS
R. E. Young 415-965-5505

The objective of this research is to increase our understanding of the dynamics, thermodynamics, and composition of the Earth's stratosphere with emphasis on atmospheric transport and its effect on the distributions of energy, momentum, and trace constituents. The research principally involves application of a 3-dimensional predictive, numerical model to important questions concerning global scale transport within the stratosphere and between the stratosphere and troposphere.

W84-70370 **147-51-02**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA SURVEY AND EVALUATION
W. B. DeMore 213-354-2436

An up-to-date tabulation and critical evaluation of kinetic and photochemical data relevant to the stratosphere will be maintained for use by atmospheric modelers, to aid in the establishment of research priorities, and to identify gaps or inconsistencies in the data base.

Planetary Geology R&A

W84-70371 **151-01-20**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY GEOLOGY
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface processes is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data as well as place boundary conditions on planetary evolution. The study of appropriate analogs not only places boundary conditions on the evolution of other planets such as Mars but also permits, on Earth, the evaluation of the characteristics of planetary surface instrumentation. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogs of Martian surface material. Through detailed grain-by-grain studies of several terrestrial soils the processes and history that can be deduced through such data will be determined. The gases released by thermal decomposition of Martian surface analog materials will be characterized and the feasibility of accomplishing such analyses in-situ will be evaluated. The volcanic stratigraphy on the surface of Io will be mapped. The thermochemical properties and kinetics of potential regolith material on Mars and Venus will be determined.

W84-70372 **151-01-60**
Ames Research Center, Moffett Field, Calif.
PLANETOLOGY: AEOLIAN PROCESSES ON PLANETS
A. L. Summers 415-965-5529

The objective of this research is to determine the parameters governing aeolian (wind) processes for appropriate planetary objects (Earth, Mars, Venus, possibly Titan), using wind tunnel simulations, laboratory experiments, Earth analog studies, theoretical studies and analyses of spacecraft data. The approach is to conduct experiments using wind tunnel and other laboratory apparatus under simulated Earth conditions, check the results in the field on Earth, then repeat the experiments in a simulated extraterrestrial environment (e.g., Martian), in order to learn about: (1) conditions for initiating and sustaining particle movement; (2) model studies of erosion and deposition associated with various land forms; (3) rates of wind erosion/abrasion; (4) study of the microtexture of materials subject to aeolian abrasion; and (5) characteristic signatures at orbital scales of aeolian landforms. Field experiments and analog studies provide a continuing check of the results from laboratory experiments and theoretical studies. Data from Mariner 9 and Viking provide information for Mars;

Pioneer-Venus and Venera data are used for Venus; and newly acquired data for the Saturn encounter allow preliminary assessment of aeolian regime on Titan.

W84-70373 **151-01-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY GEOLOGY
R. S. Saunders 213-354-3815

The principal goal of research under this program is to analyze data acquired from a variety of sources in order to understand the character, history, and evolution of solid bodies throughout the solar system. Data sources include spacecraft and groundbased observations as well as laboratory studies and field research on terrestrial analogs. Analytic thrusts emphasize the boundary-value problem approach and are philosophically oriented toward letting data constrain the range of theoretical models. Research areas are: (1) crustal evolution of solid planetary bodies; (2) process dynamics and morphological evolution of planetary surfaces; (3) laboratory investigations of water-regolith interactions; (4) characterization and interpretation of radar echoes from planetary surfaces; and (5) a systematic search for planet crossing asteroids. In addition, the NASA Regional Planetary Image Facility at JPL is supported under this RTOP. The titles of these tasks are: photogeology, planetary geomorphology and surface dynamics, planetary image facility, planetary surface physical processes, systematic search for planet-crosssing asteroids, variable features on Io, planetary radar interpretation, and global variability in morphology and morphometry of impact craters on Mars.

W84-70374 **151-02-50**
Goddard Space Flight Center, Greenbelt, Md.
STUDIES OF SMALL MARTIAN VOLCANOES IN EASTERN ACIDALIA
H. Frey 301-344-5450

This RTOP will develop an understanding of the general geologic history of the eastern Acidalia region and the significance of the origin of subkilometer Martian volcanoes determine the relation between subkilometer volcanoes and large volcanoes in knobby terrain and how these are related to the processes of scarp formation in Eastern Acidalia planitia. Terrain mapping from high resolution Viking imagery of eastern Acidalia will be completed including determination of impact crater densities for each of the plainsforming units recognized. Morphometric data for small Martian cones (cone diameter, crater/cone diameter ratio, cone density) will be plotted by terrain unit to see if these properties vary systematically with terrain or with location along the highland scarp.

W84-70375 **151-02-60**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF PLANETARY BODIES
J. B. Pollack 415-965-5530

The purpose of this research is to obtain a better understanding of selected problems pertaining to planetary surface phenomena, the composition, structure and evolution of planetary bodies and their satellites, and the origin of the solar system by means of theoretical investigations employing the results of spacecraft and ground-based experiments. Theoretical knowledge, physical insight, and mathematical modeling techniques are used, together with astronomical and geological data, to construct self-consistent mathematical descriptions of planetary processes and structures. Analysis and interpretation of the results of these model calculations are applied to such topics as wind-blown surface features and climatic changes on Mars, and aeolian phenomena on Venus and Titan.

Planetary Materials

W84-70376 **152-11-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: MINERALOGY AND PETROLOGY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to learn the pressure, temperature and chemical composition of distinct mineralogic phases at the time of their formation. Textures, structures and chemical composition of minerals found in samples of the Moon, meteorites (asteroids, comets), cosmic dust (comets, asteroids) and the Earth will be measured using optical and electron microscope and electron microprobe techniques. Comparison of these results with those from laboratory calibration experiments and theoretical models will lead to pressure, temperature and history information for parts of Solar System objects.

W84-70377 **152-13-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: CHEMISTRY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to measure the concentration of selected chemical elements (major, minor, and trace) in rock samples of interest. Data obtained supplement, and are often combined with, petrologic studies to yield bounds on thermodynamic parameters at the time of rock origin. Rock samples from the Moon, meteorites (asteroids, comets), cosmic dust (comets, asteroids) and the Earth will be analyzed using a variety of sophisticated techniques, including Neutron Activation Analysis (NAA), X-ray fluorescence, atomic absorption spectrophotometry, gamma-ray spectrometry, and proton-induced X-ray emission. Relative abundances of trace elements in different samples places bounds on the characteristics of the sources from which the rock-forming materials are derived.

W84-70378 **152-13-60**
Ames Research Center, Moffett Field, Calif.
PLANETARY MATERIALS-CARBONACEOUS METEORITES
S. Chang 415-965-6206

The objective of this research is to understand the process involved in the origin and early evolution of solid bodies in the solar system through the study of meteorites. The approach taken to meet the objective focuses on the chemical and mineralogical petrographic analyses of meteorites. The abundance, isotopic composition and distribution of selected elements are measured; and the occurrence and distribution of various mineral phases are determined. Systematic searches for elemental, isotopic and mineralogic-petrologic correlations between meteorites and within a meteorite will be made so as to elucidate physical-chemical relationships in the meteorite population. From these relationships will be deduced the nature of the processes that were involved in the origins, accretion and distribution of these objects and their components in the early solar system. In turn, these processes are modeled by laboratory or computer experiments from which the chemical and mineralogical outcomes can be determined. Findings from meteorite analyses and model studies are then compared for self-consistency.

W84-70379 **152-14-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: GEOCHRONOLOGY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to determine the absolute time when a particular event, such as the eruption of a volcano or the formation of a large impact crater, occurred. The concentrations of radioactive decay products and the corresponding parent isotopes will be measured in carefully selected rock samples using mass spectrometric techniques. With knowledge of the decay constant (half life) for the radioactive element, and assuming a closed chemical system, the time since system closure may be deduced. Systems currently in use are: K-Ar, Rb-Sr, Sm-Nd, Lu, Hf and U-Th-Pb. Study of extinct radioactive nuclides, such as Pu, leads to information on the interval of time between the formation of the nuclide and its incorporation into a solid.

W84-70380 **152-15-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: ISOTOPE STUDIES
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to determine the isotopic composition of selected elements in planetary materials. Isotopically distinct material, which cannot be understood as the product of know fractionation processes, may indicate the presence of pre-solar material. Light elements are studied to learn more about fractionation processes. A secondary objective is to develop an ion microprobe which will provide easier analysis and increased spatial resolution and sensitivity for isotopic composition measurements. Samples of Moon rocks and meteorites will be analyzed using mass spectrometric techniques to learn isotopic compositions, mainly of noble gases, hydrogen, carbon, oxygen and nitrogen. Theoretical calculations will be made to relate the expected products of nucleosynthesis to observations of anomalous material in meteorites. a commercially purchased ion microprobe is being upgraded in the laboratory of G. J. Wasserburg, CIT.

W84-70381 **152-17-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: SURFACE AND EXPOSURE STUDIES
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to learn about the interaction between the space environment, which consists of meteorites, galactic cosmic rays, and solar particle and electromagnetic radiations. Samples of the lunar regolith offer the opportunity to find variations in the intensity of the environmental factors over geologic time. A variety of approaches will be used. The radioactivity of cosmic-ray produced nuclides will be analyzed as a function of sample depth. Surfaces will be studied using electron microscopes. Etchable heavy element ionization damage tracks will be revealed and studied. Solar wind noble gases will be analyzed mass spectrometrically. Multidisciplinary studies will be done using selected samples.

W84-70382 **152-17-70**
Jet Propulsion Laboratory, Pasadena, Calif.
EXPERIMENTAL STUDIES ON METEORITES
R. S. Rajan 213-354-8094

This RTOP has four main objectives relating to the study of meteorites and cosmic dust. They are: (1) brecciation history and chronology of carbonaceous and other gas-rich meteorites; (2) fission track chronology of shergottites and implications for a Martian origin; (3) chemical and textural studies of highly unequilibrated enstatite and ordinary chondrites, with emphasis on discovery and study of relict grain containing chondrules; and (4) to measure the oxygen diffusion coefficients and O18/O16 ratios on a microscale in meteoritic minerals from the Ca-Al rich inclusions of the Allende meteorite and other relevant synthetic systems, using a newly developed nuclear resonance reaction technique. The method should be capable of measuring O18/O16 ratios in fairly large cosmic dust grains (approximately 50 microns) in the near future. Brecciation history and characterization of ancient asteroidal regoliths will be accomplished by a careful study of solar flare tracks in irradiated grains from documented sections. Fission track chronology involves studying tracks on the surfaces of characterized isolated olivines from carbonaceous chondrites. Chemical and textural characterization of highly unequilibrated enstatite and ordinary chondrites, with emphasis on relict grains, will be done by a combination of electron microprobe, SEM and optical microcopes. Detailed U-distribution studies will be done on Qingzhen, identified by us as the most primitive enstatite chondrite, with emphais on sulfides. The oxygen diffusion and isotopic studies involve (p, alpha) reactions and Rutherford backscattering and are done using the Tandem Van De Graff at Caltech campus. The nuclear resonance technique, that we have developed over the last year, will be used to measure oxygen diffusion coefficients and the O18-distribution on a microscale in relevant natural and synthetic systems to better understand the origin of oxygen isotope effects in Ca-Al rich inclusions of the Allende meteorite.

W84-70383 **152-20-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: PRESERVATION AND DISTRIBUTION
D. P. Blanchard 713-483-3274

This RTOP provides for maintenance of the Lunar Sample Collection under secure, controlled environment conditions; for the description of samples as new materials are prepared for analysis; for the maintenance records of the status and distribution of lunar samples; for providing lunar samples to approved investigators and for display purposes; and for technical monitoring of NASA-funded grants/contracts to Extraterrestrial Materials Investigators. Similar functions are also provided for the Antarctic meteorite collection, including initial description, processing for distribution to investigators, and maintenance under controlled environment; dissemination of information on meteorite collection. Staff members participate in field collection. Cosmic dust samples are collected, characterized, and distributed, using high altitude aircraft to scientific investigators. Information is disseminated. The plan provides for development of curatorial techniques for, and educational use of, materials from the various collections. Operation, which is undertaken by support contractor personnel, is directed by Civil Servant scientists and administrators. The program provides samples and information for about 65 domestic and foreign lunar sample investigator groups, over 100 meteorite investigator groups, and six to ten cosmic dust investigators.

W84-70384 **152-30-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS - LABORATORY FACILITIES
M. B. Duke 713-483-4464

This plan provides for support by JSC of a general operational nature necessary to the conduct of the OSSA Planetary Materials Program. It provides in-house laboratory maintenance and Center Operations support for the visiting scientist programs of the NASA (National Research Council, Lunar and Planetary Institute, NASA Graduate Intern, etc.) and to the Sample Curator. It provides for modernization of instrumentation to maintain optimum analytical capability for staff and visitors.

Geochemistry/Geophysics R&A

W84-70385 **153-01-60**
Ames Research Center, Moffett Field, Calif.
FORMATION, EVOLUTION, AND STABILITY OF PROTO-STELLAR DISKS
P. M. Cassen 415-965-5597

The objectives of this research are: (1) to obtain an understanding of the solar nebula and proto-stellar disks in general by analysis of theoretical models based on hydrodynamic and thermodynamic principles, and to relate these models to processes of planetary formation. The optical and infrared appearance of proto-stellar accretion disks and circumstellar dust disks are studied and the results applied to observations of solar-type, T-Tauri, and other stars in young clusters; (2) to examine the stability of proto-stellar disks against gravitational condensation, and to explore the role of instabilities in disk evolution and planetary formation; and (3) to analyze the possible roles of gravitational and magnetic interactions between protostars and their disks. Results will be analyzed in the light of observations of the solar system and astronomical objects identified as proto-stars.

W84-70386 **153-03-60**
Ames Research Center, Moffett Field, Calif.
THE STRUCTURE AND EVOLUTION OF PLANETARY BODIES
R. T. Reynolds 415-965-5532

The purpose of this research is to obtain a better understanding

of selected problems pertaining to the composition, structure and evolution of planetary bodies and their satellites and the origin of the solar system by means of theoretical investigations employing the results of spacecraft and ground-based experiments. Theoretical knowledge, physical insight and mathematical modeling techniques are used, together with astronomical and geophysical data, to construct self-consistent mathematical descriptions of planetary processes and structures. Analysis and interpretation of the results of these model calculations are applied to such topics as, the structure and evolution of the satellites of the outer planets, the outgassing history of accreting bodies and the internal structure of Uranus and Neptune.

W84-70387 **153-05-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY DYNAMICS
W. R. Ward 213-354-2594

This program of dynamical investigations is directed at increasing our understanding of solar system formation and evolution. The tasks can be grouped into three broad categories: (1) Solar system formation. Important constraints on theories of solar system formation may be provided by a study of nebula planet tides or density waves. Work on accretion and on ring dynamics will continue. (2) Asteroids and comets. Detailed mapping of the morphology of major secular resonance surfaces in (a,e,i) phase space for the asteroid belt will provide a better evalution of such resonances as a mechanism for delivery of meteoritic material to the Earth and Mars. Observations of asteroid rotations from Table Mt. Observatory and accurate measurements of the positions of selected comets and minor planets from Palomar Schmidt photographic collections and the Cunningham plates will continue. A study of the angular distribution of perihelia of new long-period comets will continue. Advanced modeling of the dynamics of the Oort Cometary cloud will proceed. (3) Planetary orbital and rotational studies. These studies will include: further investigation of the Enceladus/Dione resonance to determine the role of tidal heating in the history of Enceladus; a continuing study of Triton's orbit; and various studies of the dyanmics of small body orbiting pairs; determination of various lunar parameters from lunar laser ranging; and the estimate of shapes and volumes of various small satellites utilizing spacecraft images.

W84-70388 **153-06-70**
Jet Propulsion Laboratory, Pasadena, Calif.
THE EFFECTS OF PLASMA BOMBARDMENT OF THE ICY GALILEAN SATELLITES
R. S. Wolff 213-354-5073

The overall objective of this investigation is to determine the optical and geophysical effects of magnetospheric electron bombardment on the structure and evolution of the surfaces of icy satellites. The primary effort is the implementation of an experimental system to measure the effects of electrons on ices and condensates. Supporting theoretical work and data analysis will also be conducted. To achieve the objectives, amorphous ice will be irradiated with 1 eV to 1 KeV electrons and examined for effects measurable by remote sensing techniques (increased scattering, viewing geometry dependence, formation of color centers, etc.) The effects on the ice surfaces will be studied with respect to electron fluence, flux, energy, sample temperature, and sample type. Theoretical calculations of gardening and color center formation in ice will be undertaken. The first calculation will involve the energy loss by electrons upon passage through H2O ice. Next, a quantum-mechanical calculation of the formation of color centers in ice by bombarding electrons will be performed. Transition probabilities and optical absorptions will be calculated as a function of the electron-lattice coupling constant.

W84-70389 **153-08-00**
Lyndon B. Johnson Space Center, Houston, Tex.
EXPERIMENTAL IMPACT CRATERING
W. C. Phinney 713-483-3816

The objectives of this task are to develop a better understanding of planetary scale impact cratering and collisional dynamics processes, the mechanisms associated with them, and the results of these processes under various conditions. Experimental impacts are carried out with a vertical impact facility and a flat plate accelerator. The experimental data is then utilized with theory to provide physical and chemical constraints for the processes that can produce the naturally observed materials.

W84-70390 **153-09-00**
Lyndon B. Johnson Space Center, Houston, Tex.
EARLY CRUSTAL GENESIS
W. C. Phinney 713-483-3816

If meaningful models are to be developed for the evolution of the solar system, then physical and chemical constraints must be developed for the processes involved in the evolution of the solid objects in the solar system. The specific objectives are: to identify the key physical and chemical processes and the initial conditions for crustal evolution, to understand the evolution of planetary crusts in relationship to the overall history of individual planetary bodies, and to understand the reasons for the differences in evolution among the various planetary crusts. The strategy is to adopt an interdisciplinary and cross-planetary approach to the questions of crustal genesis. The program is a multidisciplinary effort carried out by individual scientists and teams from universities, industries, and government agencies. Major efforts will be devoted to: studying samples that are related to the early formed crusts, searching for early terrestrial crustal units, studying materials from potential terrestrial analogs of early planetary crusts, and modeling crustal evolution.

W84-70391 **153-10-00**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC GENERAL OPERATIONS - GEOPHYSICS AND GEOCHEMISTRY
M. B. Duke 713-483-4464

General operations support a variety of institutional and scientific support tasks at JSC that are considered essential for the conduct of research and for implementation of the Planetary Geophysics and Geochemistry Program. Center support services such as printing, computer, photographic, and graphics are provided to the Lunar and Planetary Institute through a procedural agreement. In-house support provides for co-sponsorship of conferences, laboratory costs required by visiting scientists using existing facilities, and for cost required to operate common laboratory facilities and to provide for support services from other Center elements.

W84-70392 **153-10-00**
Lyndon B. Johnson Space Center, Houston, Tex.
INNOVATIVE RESEARCH
M. B. Duke 713-483-4464

This RTOP provides seed funding for original ideas that potentially can be developed into programs or projects, but do not comfortably fit into existing programs. Research funded by this RTOP will be for a maximum of two years, at a level sufficient to develop concepts to the level that documented proposals can be submitted for peer evaluation. Projects may be carried out at NASA centers or outside NASA. Evaluation and selection will be done by the Center, with overview by the Headquarters program manager.

Planetary Atmospheres R&A

W84-70393 **154-10-80**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY ATMOSPHERES COMPOSITION AND STRUCTURE
G. S. Orton 213-354-2460
(154-30-80; 154-40-80; 154-50-80)

The overall objective of this research is the development of a comprehensive scientific basis for understanding the structure of planetary atmospheres and the underlying atmospheric physical

processes. The research to be carried out includes the application of techniques for remote temperature/opacity profile recovery; limb-darkening analysis; radiative transfer, and energy equilibrium and transport modelling, imaging and mapping; and molecular line-by-line transmission calculations. Using available information acquired from laboratory investigations and both ground based and spacecraft infrared observations, we propose to examine the mean values and variations in time and location of (1) temperature structure; (2) bulk chemical composition and the abundance of minor and trace chemical constituents; (3) properties of clouds and hazes, including their possible role as energetic sources and sinks; and (4) planetary internal heat sources. Using all existing constraints from direct observations we propose to derive the atmospheric temperature structure using accurate models for the deposition of solar energy, the deposition of planetary (infrared) energy, relative contributions of radiative and convective energy transport mechanisms, and the potential contributions of other sources and sinks of energy. The equilibrium models for energy transport will be based on a straightforward flux divergence formulation, using direct energy conservation expressions.

W84-70394 **154-10-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERIC COMPOSITION, STRUCTURE, AND HISTORY
J. B. Pollack 415-965-5530

Theoretical modeling and spacecraft data interpretation are used to determine the properties and physical processes characteristic of planetary atmospheres. These properties include their temperature structure, aerosols, cloud layers, gaseous constituents, and opacity sources. Emphasis is placed on reducing and analyzing data returned from spacecraft missions, such as Pioneer Venus and Voyager or preparing for data expected from future spacecraft missions, such as Galileo. However, use is also made of relevant ground-based observations. In addition, the origin and evolution of planetary atmospheres are studied by constructing models that are constrained by relevant spacecraft and ground-based data.

W84-70395 **154-20-80**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMICS OF PLANETARY ATMOSPHERES
J. A. Pirraglia 301-344-6783
(889-56-47)

The objective is to apply geophysical fluid dynamics to planetary atmospheres in general and to study similar dynamical phenomena under different conditions. The planets and their satellites present contrasts in mass, rotation rate, radiative time constants, heat deposition, and topographic influence on their atmospheres. These disparate atmospheres present an opportunity to apply theoretical models to a wide range of parameter space using the data obtained from planetary missions. Atmospheric circulation is strongly affected by energy and momentum transport. The nonlinear interactions between the mean flow and waves that contribute to the transport processes will be investigated. This will be accomplished by the development of a nonlinear spectral solution of the equations which describe the wave mean flow dynamics. The spectral model will be used to study the role of instabilities and forced waves in the transport of energy and momentum under the variable boundary conditions encountered on the planets.

W84-70396 **154-20-80**
Jet Propulsion Laboratory, Pasadena, Calif.
DYNAMICS
R. W. Zurek 213-354-3725

The objectives proposed under this RTOP are to understand the planetary scale evolution of Martian great dust storms by simulating the basic interaction between dynamics and radiatively active airborne dust so prominent in the dusty Martian atmosphere, and to understand the mechanisms responsible for the high latitude circulation above the Venus cloud tops, in general, and for the longitudinally asymmetric polar thermal features, in particular. Emphasis is on models which are well constrained by the Pioneer Venus data.

W84-70397 **154-20-80**
Ames Research Center, Moffett Field, Calif.
DYNAMICS OF PLANETARY ATMOSPHERES
R. E. Yound 415-965-5515

The dynamics of the atmospheres of Venus and Mars are being studied using multi-dimensional circulation models. The coupled momentum and energy equations are solved numerically using combinations of finite difference and spectral methods. The principal goals are to compare model results with spacecraft data and attempt to understand the dynamical effects of varying planetary rotation rate, solar energy deposition, infrared opacity, atmospheric mass and composition.

W84-70398 **154-30-80**
Jet Propulsion Laboratory, Pasadena, Calif.
CLOUDS, PARTICULATES AND ICES
R. J. Terrile 213-354-6158
(154-10-80; 154-30-80; 154-40-80)

This RTOP covers: (1) infrared emission of cometary dust; (2) Venus cloud properties; (3) Jovian and Saturnian cloud properties and Saturn's rings spokes; and (4) outer planet cloud investigation. The objective of the cometary dust study is to compute the thermal emission of cometary dust grains as a function of particle size, wavelength and heliocentric distance in order to derive the composition and dominant size range of the dust being emitted from specific comets. The models are also applied to predicting dust emission characteristics for potential target comets of a cometary mission. The Venus cloud study seeks to understand the vertical structure of the Venus Cloud deck and its global variability over the planet. Mariner 10 and Pioneer Venus radio occultation data, orbiter infrared radiometer data, and probe data are used to determine the structure of clouds. Voyager imaging and IRIS data, combined with high resolution ground based 5 mm images will be used to determine physical parameters for the Jovian and Saturian clouds. A study of spoke phenomena in Saturn's rings is also included. The outer planet cloud investigation will deduce location, vertical extent, optical depth, single scattering albedo, and refractive index of clouds and aerosol particles in the upper atmospheres of Jupiter, Saturn, Titan, Uranus, and Neptune from combined visible and near infrared observations of reflected solar radiation.

W84-70399 **154-40-00**
Goddard Space Flight Center, Greenbelt, Md.
RADIATIVE TRANSFER IN PLANETARY ATMOSPHERES
L. D. Travis 212-678-5599

This RTOP supports all the planetary work at GISS other than specific tasks which are part of GISS spacecraft experiments (OCPP on Pioneer Venus and PPR on Galileo). The general objectives are to apply techniques for extracting information on planetary atmospheres from radiation measurement and to investigate radiative, cloud, and dynamical processes and their interactions in planetary atmospheres. Applications to Venus and Jupiter in progress are expected to yield general information on cloud, aerosol and dynamical processes in planetary atmospheres, which will also help improve our understanding of the Earth's atmosphere and climate system. Principal elements in the approach are analysis of available spectral and polarimetric data for Venus and Jupiter to obtain information on atmospheric structural and cooperative studies with university researchers to investigate radiative, cloud, and dynamical process, with focus on radiative/convective modeling of the atmospheres of Venus and Jupiter and study of cloud/radiation/dynamics feedbacks.

W84-70400 **154-40-80**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING OF ATMOSPHERIC STRUCTURES
G. S. Orton 213-354-2460
(154-10-80)

The objective of this research is the development of accurate numerical approaches for the interpretation of infrared remote sensing data obtained under realistic conditions in the presence of anticipated measurement noise, as well as in the presence of

clouds and aerosols. Five important problems will be addressed: (1) determination of atmospheric temperature profiles in the presence of clouds and aerosols when cloud cover is uniform or when temperature and cloud variations are highly correlated; (2) determination of both macro-and microphysical cloud properties; (3) determination of temperature in the presence of strong positive temperature gradients; (4) determination of gaseous abundance profiles in the presence of clouds; and (5) assembly of requisite molecular spectroscopic data for the application of these techniques in the outer solar system. The approach will use a relaxation technique developed by Chahine, coupled with accurate and efficient radiative transfer algorithms, together with a simultaneous theoretical approach to these problems. Testing of these techniques will be done using numerical simulations of data, comparing the conditions of the generating model with those retrieved by the technique. The model test environments of significance in the near term will be the outer planets and Mars, in support of Voyager and Galileo data analysis and future mission experiment planning.

W84-70401 **154-50-80**
Jet Propulsion Laboratory, Pasadena, Calif.
ATOMIC AND MOLECULAR PROPERTIES
G. S. Orton 213-354-2460

A broad program of theoretical and experimental studies pertaining to planetary atmospheres will be conducted with the following primary objectives: (1) to understand the properties and determine the parameters of the constituents of planetary atmospheres; (2) to apply experimental data (laboratory, astronomical and spacecraft) to the understanding and interpretation of spectral features of complex planetary atmospheres; and (3) to apply these findings toward the design of ground-based and spacecraft experimental concepts. The studies to be conducted in FY84 represent the continuation of a collabortive effort with Dr. G. Birnbaum of the National Bureau of Standards on long path, multithermal measurements of the opacity of the major constituents of planetary atmospheres. The study of the high resolution infrared spectrum of NH3 represents a new task to help provide information needed for interpretation of the Jupiter and Saturn data from the IRIS instrument on the Voyager mission and for the Galileo NIMS instrument at Jupiter.

W84-70402 **154-50-80**
Goddard Space Flight Center, Greenbelt, Md.
ATOMIC AND MOLECULAR PROPERTIES OF PLANETARY ATMOSPHERIC CONSTITUENTS
John J. Hillman 301-344-7974
(196-41-54; 147-10-01; 188-41-55)

The principal goal of this laboratory spectroscopy program is to develop an organized body of knowledge of the molecular properties of planetary atmospheric constituents. In the case of lower resolution planetary observations, such as Voyager IRIS (4/cm), identifications and abundance determinations require laboratory spectra of similar resolution which can be directly compared with the observations. The highest possible spectral resolution is required when single features apparent in medium or high resolution Fourier transform (FTS) spectra are composed of more than one molecular transition, and the parameters frequency, strength, lower state energy, and foreign-broadening must be known for each as input in modeling the atmosphere. For infrared heterodyne observations, the need for ultra-high resolution laboratory data is especially critical, since the bandwidths accessible to these receivers are narrow and Doppler line profiles are completely resolved in the observed spectra. A combination of tuneble diode laser (TDL) and FTS laboratory spectra can supply a complete set of line parameters anywhere in the infrared. In this program, TDL and FTS spectrometers will be applied to selected vibration-rotation bands of planetary molecular species. Tasks include: (1) analyses of new molecules identified by Voyager IRIS in Titan and Saturn; (2) analysis of C2H6, nu(9) transition strengths, temperature dependence, and broadening; (3) publish measurements of frequencies and strengths in nu(3) and nu(6) of CH3D; (4) obtain N2 broadening parameters of H2 (Titan atmosphere; and (5) complete analysis of 4 mm fundamental of N2.

W84-70403 **154-60-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY THEORY AND ANALYSIS/COMET MODELS
W. T. Huntress, Jr. 213-354-8275
(154-75-80)

Theoretical chemical models will be constructed of the chemical structure of cometary comae. The first objective is to derive constraints on the initial composition by comparison with observation, and thus make deductions concerning the origin of comets. The second objective is to prepare a model of the ion coma for comparison with IUE data and to provide a pre-encounter model for the Giotto ion mass spectrometer team.

W84-70404 **154-60-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY AERONOMY: THEORY AND ANALYSIS
R. E. Hartle 301-344-8234

The basic objective is to study the observed properties of the neutral atmospheres and ionospheres of the planets and their satellites, including Earth, in order to identify and interpret the physical and chemical processes governing their behavior, encompassing solar planetary relationships. The motivating philosophy here is that the study of processes occurring in the atmospheres and ionospheres of the planets and their satellites provides important insights into the nature of similar processes operative in the Earth's atmosphere and ionosphere under different parametric conditions and vice versa. The investigations are pursued by analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated. The data are used to determine the various chemical, compositional, dynamical and energetic states of the respective atmospheres and ionospheres, including the transport and deposition of mass, momentum and energy in these regimes. In general, the approach involves the development of empirical descriptions of either global or small scale phenomena using data sets from a variety of spacecraft. These empirical descriptions of the atmospheres and ionospheres are subsequently interpreted using theoretical models developed to deduce the physical and chemical processes involved. Some of the specific phenomena addressed in this investigation include: atmospheric and ionospheric motions on Venus, Jupiter and Earth, interactions of solar wind and/or magnetosphere with atmospheres of Venus, Titan, and Earth, including modification of transport coefficients by plasma instabilities, solar planetary relationships, comparative planetary atmospheres, etc.

W84-70405 **154-70-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: ENERGY DEPOSITION
S. Trajmar 213-354-2145

Electron impact excitation, ionization and lifetimes of excited states of species which are important in planetary environments (with major emphasis on the Jupiter and Saturn environment) will be studied. Cross sections for these processes will be measured. The emphasis will be on the excitation and dissociation of H2. In addition, ionization, dissociative ionization and attachment cross sections for CH4 will be measured. Lifetimes of the excited states of OI(1039A) and CII(1035A and 1335A) will be determined. Electron-impact cross sections will be measured for visible and EUV emission lines, observed from ground-based telescopes and by Voyagers 1-2 in the Jupiter-Io torus, originating in the ions OII and SII. The transitions to be studied are 4 S yields 4 P and 4 S yields 2 D, 2 P and 4 P in both ions. The respective wavelengths are, for OII 373, 247 and 83.3 nm, and for SII 672, 407.4 and 125.6 nm. In addition, the elusive SII transition 4 S yields 2D, 2P and 4P at 86.3 or 76.5 nm will be studied to determine whether this emission feature arises in SII, on some other ion or charge state. Data will be provided to the modelers of the torus, and the current effort anticipates the rich return of EUV observations in the Galileo program, and the cross-section base which their interpretation will require. The measurement of optical emission cross sections and fluorescence spectra arising from electron impact is the main goal of the UV emission processes program.

In detail, we plan to perform systematic and comprehensive studies in the UV region of the spectrum (50-500nm) of atoms, (S, C, O, N, Na, Ar, K) and molecules SO2, CH4, H2O, CO2, CO, NH3, CS2, N2) of planetary and cometary interest.

W84-70406 **154-75-80**
Goddard Space Flight Center, Greenbelt, Md.
COSMIC CHEMISTRY: AERONOMY, COMETS, GRAINS
B. Donn 301-344-6859

This RTOP studies physicochemical phenomena in planetary atmospheres, comets, and related aspects of interstellar matter. Laser spectroscopy, photochemistry, reaction kinetics, and condensation processes are investigated and properties of atoms, radicals, molecules, and grains are measured. These experimental results are used to interpret astronomical observations and develop theoretical models. Flash photolysis-resonance fluorescence apparatus with computer interface for real time analysis yields absolute atom-molecule rate constants. CW tunable dye laser is used for radical detections. Mass spectrometry will be added to discharge flow system. An excimer laser, alone or combined with a flashlamp, is used for sequential photodissociation studies of planetary or cometary radicals. A tunable dye laser is used to detect and study the properties of these radicals. Gas phase and matrix isolation condensation are used to simulate production of primordial solar system, cometary or interstellar grains and study mechanism of production. Particle accelerator irradiates ice mixtures to study cosmic ray effects on comets. Experiments to determine vaporization process for ice mixtures are planned using method currently under study.

W84-70407 **154-75-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: CHEMISTRY
W. T. Huntress, Jr. 213-354-8275
(154-60-80)

The objective of this work is to conduct laboratory investigations of the ion chemistry of planetary atmospheres and cometary comae. The goal of the ion chemistry work is to obtain product distributions and rate constants for ion-molecule reactions important in the atmospheres of the planets, their satellites, and in cometary comae. The goal of this work is to elucidate the chemistry of the Venus atmosphere in the 60-90 km region. The roles of SO2 and HCl in the Venus atmosphere will be studied, with the particular objectives of explaining the photochemical stability of CO2 and the detailed sulfur chemistry leading to cloud formation. Photochemical experiments relevant to hydrocarbon chemistry in the Titan atmosphere will be conducted.

W84-70408 **154-80-80**
Jet Propulsion Laboratory, Pasadena, Calif.
EXTENDED ATMOSPHERES
Z. Sekanina 213-354-7589

The overall objectives of this investigation are to investigate the dynamical response of the dayside ionosphere to changing solar wind conditions; to analyze the structure of MHD discontinuities observed within the Venus ionosphere; and to study the coupling of the ionosphere and neutral atmosphere. High resolution PVO OIMS, OETP, ORPA, OMAG, and OPA data for orbits 170-184 will be analyzed to: (1) examine the structure of observed MHD discontinuities within the ionosphere; (2) determine whether or not some of these observations are, in fact, multiple ionopause crossings; (3) attempt to separate out zenith angle and latitude-dependent effects in the ionospheric density and temperature profiles (Theoretical calculations of the propagation of small amplitude magnetoacoustic-gravity waves in the Venus ionosphere will be made; and 1-D numerical simulation (w/R. F. Stein of MSU) of the response of the dayside ionosphere to changing solar wind conditions will be continued. These calculations shall include the effects of horizontal magnetic fields and ion-neutral coupling. The nature of the cometary nucleus and the ejected dust are investigated by techniques which combine a dynamical approach with photometric considerations and which include methods of the fireball theory. The aim is to interpret a broad range of dust phenomena in the coma and tail, to assess the material strength of the nucleus, the degree of heterogeneity of its surface, and to determine the rotational constants of comets. Towards these objectives, a study of the surface morphology of Comet Halley will continue, and to this end high resolution photographs from the comet's 1910 apparition are being collected, digitized, and image processed at the present time in collaboration with Mr. S. M. Larson at the U. of Arizona. In addition, a study of dust particle fragmentation in Comet 1910 I will be performed (in collaboration with J. A. Farrell at Los Alamos Nat'l. Laboratory), outgassing asymmetry for short-period comets will be investigated, and work will continue on split comets.

W84-70409 **154-80-80**
Goddard Space Flight Center, Greenbelt, Md.
EXTENDED ATMOSPHERES
H. A. Taylor, Jr. 301-344-6610

The objective of the RTOP is to advance the understanding of comparative solar planetary relationships. Global characteristics of ionosphere-neutral atmosphere variations are studied, as indicators of energy coupling processes regulating the upper atmosphere in the region extending from cloud levels to the ionopause. By examining the behavior of the ionic constituents at lower altitudes near the exobase and at higher altitudes approaching the ionopause, insight is obtained with respect to collision dominated as well as collisionless processes. Studies of Venus will examine longer term effects, such as the basic planetary atmosphere evolution, as well as short term effects such as the ion and neutral response to variations in solar radiation and in the solar wind. The approach involves the analysis of global sets of planetary and interplanetary satellite data describing the composition, structure, and energetic states of the planetary atmosphere-ionosphere system. The study emphasizes phenomenological data sets descriptive of uniquely varying conditions or events. Results of the empirical studies are assessed in terms of current theoretical models. Comparison of model results for contrasting planetary conditions, e.g., Earth and Venus, are performed to test basic physical concepts. Program support to the Planetary Programs Office is also provided under this RTOP.

W84-70410 **154-90-80**
Jet Propulsion Laboratory, Pasadena, Calif.
IO ATMOSPHERE/SURFACE DYNAMICS
R. M. Nelson 213-354-6893

Compounds of sulfur and oxygen have been proposed as probable gaseous constituents of Io's atmosphere and as condensates on Io's surface based on results from the Voyager spacecraft and IUE-groundbased observations of Io's surface and magnetosphere. Although sulfur, sulfur allotrops and sulfur dioxide are likely candidates, there are a variety of other sulfur oxygen compounds which have been studied at best on a preliminary basis only. These include sulfur trioxide (SO3), sulfur sesquioxide (S2O3) and disulfur monoxide (S2O). The results will provide limits on the atmospheric and/or surface distribution of these suspected Io surface components.

Halleys Comet Watch/Experiments

W84-70411 **156-02-02**
Jet Propulsion Laboratory, Pasadena, Calif.
INTERNATIONAL HALLEY WATCH
R. L. Newburn, Jr. 213-354-2319

The International Halley Watch has been designed to maximize the scientific value of ground-based observations of Halley's Comet. Important in their own right, such observations will also enhance the value of space observations, setting the brief duration flyby data in the context of the overall apparition, placing the extremely high resolution encounter data into the normal scale of observations, and filling in missing data. Its goals are to standardize observing techniques wherever useful and possible, to coordinate the observing, and to collect and publish all data in a comprehen-

sive Halley Archive. The IHW is designed to avoid the problems of 1910 where the two major monographs on Halley were not published until 21 and 24 years later and where much data remains unpublished to this day. Individual nets of observers worldwide have been organized for each observing technique by seven Discipline Specialist teams. Overall IHW coordination internally and with flight projects is the responsibility of a Lead Center Organization (LCO) established in Pasadena, CA, USA and Bamberg, FRG, as is the responsibility for IHW publications. Advice and oversight protection are supplied by a 23 member Steering Group. Amateur contributions are being coordinated by the LCO, working through Recorders (amateur comet specialists) and existing amateur organizations.

W84-70412 **156-02-02**
Goddard Space Flight Center, Greenbelt, Md.
THE LARGE-SCALE PHENOMENA PROGRAM OF THE INTERNATIONAL HALLEY WATCH (IHW)
John C. Brandt 301-344-8701

The major objectives of this program are: (1) to construct a worldwide network of observatories with wide-field imaging capability for participation in the Large-Scale Phenomena portion of the International Halley Watch; (2) to scientifically analyze the imagery obtained from the net using sophisticated state-of-the-art computer image processing techniques; (3) to provide support to the deep space comet Halley missions flown by international space agencies. The International Halley Watch (IHW) is an organization whose steering group is composed of members from many countries and whose purpose and function--the advocacy of worldwide observations of Halley and the collection and analysis of any data such obtained--has been officially endorsed by the International Astronomical Union (LAU). The present investigator (J. C. Brandt) has been selected as Discipline Specialist for the Large-Scale Phenomena program of the IHW. He and his science team will administer this program via the construction of a worldwide network for the observation of large-scale phenomena such as rapidly-variable plasma-tail features and similarity wide-field dust-tail structures. The program's modus operandi requires the forwarding by participating observatories of their best photographic plates (or film copies) to the science team for analysis. Individual observatories retain full proprietary rights to the analysis of their own data whereas the Discipline Specialist and his team reserve the right to analyze the worldwide data as a whole.

W84-70413 **156-03-01**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO HALLEY MODELLING
R. L. Newburn, Jr. 213-354-2319

The primary objective of this task is creation of detailed, quantitative, environmental models of Halley's Comet to aid in proper design of a spacecraft and of spacecraft instruments. Two efforts are under way to model P/Halley. One aims at understanding the range of physical parameters of normal comets, placing Halley among these by use of its light curve (brightness vs. time) determined in 1910. The other attempts to better understand Halley through study of all available 1910 observations. The general models are advancing toward a self-consistent set of physical parameters, with only a few free parameters to be based upon observation. The 1910 photographic plates are being computer enhanced to aid the second approach. The general theory is being programmed to provide environmental models along any selected spacecraft trajectory.

W84-70414 **156-03-03**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO ION MASS SPECTROMETER CO-INVESTIGATOR SUPPORT
M. Neugebauer 213-354-2005

The Ion Mass Spectrometer to be flown on the Giotto mission is based, in part, on a High Energy Range Spectrometer (HERS) developed at JPL. The objectives of this task are to (1) optimize the design of this instrument for use on Giotto; (2) generate an end-to-end computer simulation of the trajectories of ions through the instrument; (3) perform experimental checks of the optical design; and (4) support the Principal Investigator of this experiment as required. The approach involves both computer simulation of the instrument and construction and testing of critical elements at the breadboard level. Frequent contact between all team members is maintained to coordinate interfaces and requirements. This task also involves the generation of required documents, support of instrument calibration, development of data-reduction algorithms, evaluation of instrument performance, analysis of flight data, and submission of reduced data to the National Space Science Data Center.

W84-70415 **156-03-04**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO PARTICULATE IMPACT ANALYZER (PIA) CO-INVESTIGATOR SUPPORT
Z. Sekanina 213-354-7589

There are three primary objectives under this task. The first is the theoretical support for the PIA experiment (Sekanina, Zook) which includes the study of the dust environment of Comet Halley, the formulation of dust models, and the structure of the surface layer of the comet's nucleus. The second objective is the laboratory support for the experiment (Brownlee, Clark, Utteback) which includes a study of fine-grained extraterrestrial particles by a laser mass spectrometer, by an ion microprobe, and via X-ray microanalysis in the scanning electron microscope; the preparation of test projectile particles; the provision of test results and circuit design information related to the impact light-flash subsystem and the high speed ion sensor subsystem; and the assistance in developing and applying a laser blow-off ion source for particle impact simulation in flight readiness tests. The third objective is the participation in the flight data reduction and interpretation (all co-investigators) which includes the conclusions on the particle composition, mineralogy, dust production, particle-mass distribution, and nucleus structure and evolution.

W84-70416 **156-03-05**
Goddard Space Flight Center, Greenbelt, Md.
GIOTTO, MAGNETIC FIELD EXPERIMENT
Mario H. Acuna 301-344-7258

We shall participate in the magnetometer experiment for the GIOTTO mission to Comet Halley. This experiment will provide rapid (up to 30 vectors/sec), precise (0.1%), accurate and very sensitive (+ or - 0.004 nT) vector measurements over a wide dynamic range (7 ranges from + or - 16 nT to + or - 65536 nT, with the uppermost ranges for easy check-out during S/C integration) of the magnetic fields observed during the GIOTTO encounter of Comet Halley in March 1986. Near closest approach, we shall be most interested in the possible signatures in the magnetic field of dynamical processes originating near the cometary nucleus and the possibility of an intrinsic cometary magnetic field. The latter objectives would obviously be favored by an encounter as close to the nucleus as possible. Another major objective is the study of the interaction between Comet Halley and the solar wind at 0.897 AU. This includes the identification of boundary surfaces such as an expected cometary bow shock and the transition region between a cometary magnetosheath and the cometary atmosphere closer to the comet. In addition, we shall investigate the role of the magnetic fields in the coma and magnetosheath, dynamical phenomena in the plasma interaction caused by temporal variations of the cometary gas and plasma source during the fly-by and wave phenomena generated by instabilities in the various magneto-plasma regions and regimes.

W84-70417 **156-03-07**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO DUST IMPACT DETECTION SYSTEM (DIDSY) CO-INVESTIGATOR SUPPORT
M. S. Hanner 213-354-4100

This RTOP covers the activities of two co-investigators on the GIOTTO DIDSY experiment. There are two objectives: (1) Theoretical study of the dust environment of Comet Halley, based on 1910 data from Halley and recent data from other comets, prior

to the GIOTTO encounter, in order to assist the DIDSY team in experiment definition, flight strategy and data interpretation. (2) Participation in the analysis and interpretation of the DIDSY data after encounter, with emphasis on the particle mass distribution, spatial distribution, dust production rate, and relation to the large body of optical and infrared remote sensing data. Models of the dust flux, mass (size) distribution, and potential temporal and spatial variation for Halley's Comet will be developed, based on observed structure in the coma of Halley's Comet in 1910, the orientation of the dust tail, and analysis of the dust thermal emission and optical scattering in recent comets expected to be similar to Halley. The co-investigators will participate in the analysis of the DIDSY data, with emphasis on the mass distribution, spatial and temporal variations, and the relation between the in-situ DIDSY measurements and remote sensing optical and infrared data.

Planetary Instrument Definition

W84-70418 **157-03-40**
Lyndon B. Johnson Space Center, Houston, Tex.
MASS SPECTROMETRY-ISOTOPE DILUTION (MSID) EXPERIMENT DEVELOPMENT
L. E. Nyquist 713-483-5579

This RTOP is to continue definition of the Mass Spectrometry-Isotope Dilution (MSID) experiment for future use in the analysis of planetary materials by unmanned spacecraft. The instrument concept is most fully described in a proposal submitted in response to the announcement of opportunity for the International Comet Mission (A.O. No. OSS-2-79). The approach adopted has been to begin definition of the Sample Processing System (SPS) which prepares the sample for mass spectrometry. Simultaneously, we will separately set up a small mass spectrometer of a type which could be used for the flight instrument utilizing available equipment where possible. We have prioritized the development of individual components of the SPS. Functional verification models of the two highest priority units, the sample canister and the pipette pump, have been developed and are currently being tested. The fabrication of the next highest priority unit, the metering pump, is nearing completion. Continuation of the current level of effort should permit development of six of the nine components of the SPS by the end of FY-83. In FY-84, an end-to-end bench top functional verification model of the SPS will be assembled and automation of its functions will begin.

W84-70419 **157-03-50**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY INSTRUMENT DEVELOPMENT
J. I. Trombka 301-344-5941

The objective of this investigation is to develop remote sensing and in-situ measurement systems for geochemical and geophysical exploration of the planets, asteroids and comets. These studies will be consistent with the planetary program recommended by the Solar System Exploration Committee (SSEC). The remote sensing X-ray spectrometer study will consider proportional counters, solid state detectors, and imaging systems. Elemental composition for elements with atomic numbers greater than Z=6 (carbon) using solar X-ray fluorescent spectral measurements are being considered. Both theoretical and experimental studies will be used in the investigative program. Both gamma-ray and X-ray detector systems are significantly affected by the space radiation environment. Both induced backgrounds and radiation damage in gamma-ray detectors (i.e. NaI(Tl), CsI(Na), Ge(Li) and Ge(high purity)) have been studied and methods for predicting the magnitude of these effects are under development. These studies will be confirmed. There is not a great deal of information available on the effects of the space radiation environment on X-ray detectors. Balloon flights of remote sensing gamma-ray and X-ray spectrometer systems will be flown in order to ascertain their sensitivities and the magnitude of the space environment induced activity. If soft landings on planetary, asteroid or cometary bodies are possible, in-situ elemental analysis can be performed utilizing X-ray fluorescence and neutron-gamma-ray techniques.

W84-70420 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
SEMPA GAMMA-RAY
A. E. Metzger 213-354-4017

This RTOP supports two tasks: development of a miniaturized Scanning Electron Microscope and Particle Analyzer (SEMPA) as a potential flight instrument for inclusion on any mission that samples a planetary body or cometary dust; and development of a gamma-ray spectroscopy remote sensing space experiment to determine concentration and distribution of naturally radioactive and cosmic-ray-excited isotopes for a variety of elements in the surfaces of solar-system bodies. The SEMPA (Scanning Electron Microscope and Particle Analyzer) breadboard was built to demonstrate a light-weight, low electrical power flight instrument concept for elemental analysis of particles as small as 0.24 micrometer and for imaging with a resolution of 0.04 micrometer. The breadboard instrument is now in operation and has yielded images with a resolution of 0.3 micrometer, better than expected with the tungsten cathode now in use. A digital beam control is now being installed. In FY-84 we will install a LaB6 cathode to demonstrate the resolution goal of 0.04 micrometer and corporate an X-ray detector to begin demonstration of the elemental analysis capability. The advanced gamma-ray spectrometer utilizes a large high resolution Ge detector with sensitivity greatly superior to the Apollo instrument. Scientific and engineering studies are aimed at evaluating the capabilities of the system and developing the long-lead technology subsystems needed to demonstrate feasibility. These include thermal and mechanical testing of Ge detector assemblies, study of gamma-ray response characteristics, establishing the influence of heavy ion bombardment, design and fabrication of the radiative coolers and the addition of a neutron mode which will minimize dependence on modeling where ground site validation is unavailable.

W84-70421 **157-04-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY ATMOSPHERE EXPERIMENT DEVELOPMENT
H. B. Niemann 301-344-8706

The objective of this work is to develop instrumentation and necessary specialized test and calibration techniques for in-situ neutral gas and ion composition and density measurements in planetary atmospheres. The instrument development is focussed on neutral gas and ion mass spectrometry. Different atmospheric environments encountered in various planetary missions as well as the different scientific goals set for the studies of the planets require instrument performances which are highly mission specific. Work will be done in three areas: (1) Mass Spectrometer Sensor Development. Ion source efficiencies will be optimized for operation in high particle velocity regimes (> or = 50 km/sec). High pressure ion source and large dynamic range analyzer systems will be developed for trace gas detection. (2) Sample Inlet Systems. Compact gas leaks for pressure reduction from high pressure atmospheres to ion source operating levels and sample enrichment techniques for trace gas analysis will be developed. (3) Calibration and Test Equipment. Intermediate velocity molecular and atomic beam systems and trace as mixing systems will be developed to simulate expected planetary and cometary atmosphere conditions for evaluation of instrument performance and calibration.

W84-70422 **157-04-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERES - INSTRUMENT DEVELOPMENT
G. C. Carle 415-965-5765
(199-50-42; 199-30-52)

To develop highly miniaturized, powerful instrument technology which can be used for future flight instruments which will be used in solar system exploration. Subject instruments are to be extremely efficient in analytical capability while modest in requirements for spacecraft volume, weight, and power. Conduct research and development efforts in advanced instrument concepts for study of

planetary atmospheres in solar system exploration. Research studies will be directed toward the development of flight type breadboards which will serve to specify future flight experiments for selected missions.

W84-70423 **157-04-80**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED EXPERIMENT DEVELOPMENT
D. J. McCleese 213-354-2317

The objective of this task is the development of advanced infrared instrumentation for NASA's program of planetary exploration from spacecraft. The emphasis is on the following atmospheric science goals: (1) determine the thermal structure and its spatial and temporal variability in the terrestrial and outer planets; (2) map the abundance and vertical, lateral and temporal variability of key atmospheric species; (3) measure, by direct and indirect means, atmospheric motion; and (4) determine the physical properties of clouds and aerosols. The investigation of surface phenomena is also of fundamental importance in the rational development of infrared instrumentation. In particular, our objective is the application of infrared remote sensing to the identification of surface materials, determination of surface cooling rates, thermal inertia measurements, and the mapping of surface morphology. The approach will be to develop in the laboratory the critical hardware for an advanced infrared sounder. This developmental instrument is both versatile in the science goals which it can address and is sufficiently flexible to permit its use in future terrestrial and outer planet flight opportunities. To undertake this task, we have at JPL an experienced infrared experiment team with expertise in hardware development, atmosphere and surface studies, and data analysis techniques.

W84-70424 **157-05-50**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY INSTRUMENT DEVELOPMENT PROGRAM/ PLANETARY ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-50; 196-41-54; 188-41-55)

This RTOP supports the development of components for advanced generation infrared spectrometers for planetary observations. Task-02 addresses the development of compact, power efficient infrared heterodyne spectrometer components suitable for eventual space flight use. Particular emphasis is placed on developing RF-excited waveguide CO2 lasers, passively cooled photomixers and pre-amplifiers, and integrated acousto-optic spectra line receivers. Task-03 addresses development of a long travel, magnetically suspended, cryogenic carriage for the moving mirror of a Fourier transform spectrometer. Following verification of the performance of the cryogenic carriage, a brass-board interferometer will be assembled and tested to verify its suitability for future space flight use.

Solar Terrestrial and Astrophysics ATD

W84-70425 **159-41-01**
Ames Research Center, Moffett Field, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTOR FOR INFRARED AND SUBMILLIMETER ASTRONOMY
R. Bruce Pittman 415-965-6525
(506-62-21)

The objective is to refine and develop concepts for a Large Deployable Reflector (LDR) in space. The LDR will be a free-flyer with a diameter greater than 10 meters to provide access to a broad range of infrared and submillimeter wavelengths and serve a widely based community of scientific users. Work supported by this RTOP can be divided into two parallel and interconnected efforts. The first involves a System Concept and Technology Definition Study to examine overall systems issues such as the configuration, orbit and deployment schemes, and to assess the state of technology readiness to implement the system concept. The second involves the continued refinement of the scientific rationale and the related set of science requirements developed at the LDR Science/Technology Workshop, the evaluation of specific scientific and technical issues by the science community, and the oversight of technical studies such as the system study by a scientific advisory committee. These two efforts, together with concurrent technological studies and developments funded by OAST, will ultimately form the basis of an OAST technology initiative aimed at providing the desired level of technology in order to proceed with LDR with confidence and minimum risk. Work under this RTOP will be done in cooperation and coordination with JPL, LaRC, LeRC, and GSFC.

W84-70426 **159-41-01**
Jet Propulsion Laboratory, Pasadena, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTORS (LDR) FOR ASTRONOMY APPLICATIONS
J. D. Burke 213-354-6363

The objective is to continue advanced studies of science and precursor science experiments in support of a projected Large Deployable Reflector (LDR) flight mission. The work in FY-84 is to be closely coordinated through the science and technology working groups with the major technology development being led by the Ames Research Center. Under this RTOP, consideration will be given to focal-plane optics and instrument development needs as affected by science requirements, and studies will continue on the utilization of SPARTAN as a possible LDR instrument test vehicle.

W84-70427 **159-41-03**
Marshall Space Flight Center, Huntsville, Ala.
ORBITING VLBI FEASIBILITY STUDY
S. H. Morgan 205-453-3430

The purpose of this RTOP is to aid in assessing the feasibility of extending the Very Long Baseline Interferometry (VLBI) technique into space by placing one of the receiving stations in Earth orbit. The first step in an evolutionary sequence that would eventually lead to a mature free-flying VLBI observatory is to accommodate VLBI observations on the deployable antenna aboard the space shuttle. This RTOP will assess the feasibility of doing VLBI observations on this experiment and establish the experiment requirements. The scientific, functional and operational requirements for a shuttle attached deployable antenna to accommodate VLBI observations will be established in conjunction with interested scientists. Using these requirements, the feasibility of accommodating VLBI observations will be assessed.

W84-70428 **159-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
ORBITING VERY LONG BASELINE INTERFEROMETRY (OVLBI)
J. F. Jordan 213-354-7790

The objectives of this RTOP are: to delineate the scientific goals and systems for the space applications of VLBI and provide for assessment studies of future space VLBI missions. A joint NASA-ESA VLBI explorer level mission has been proposed. The JPL will provide scientific and engineering support for mission assessment studies to be performed jointly between NASA and ESA. The JPL will also provide scientific support for a readiness demonstration of space-VLBI technologies using the TDRSS. The NSF Astronomy Survey Committee in 1980 determined that a VLBI mission ranked as a high national scientific priority. Tasks in FY-84 are to: (1) generate a science requirement document to guide the pre-phase A QUASAT mission studies; (2) participate with ESA in a pre-phase A mission assessment study of the QUASAT concept; (3) help organize and participate in an International Space VLBI Workshop, to be held in 1984; and (4) organize and initiate a phase study for the QUASAT mission.

W84-70429 **159-46-01**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF)
C. C. Dailey 205-453-0162

The AXAF will be a shuttle-launched and maintained X-ray

observatory with a lifetime of about 15 years. It will provide significant improvements over all previous research capabilities in X-ray astronomy by its long life, its high performance optics, and its sophisticated instrumentation. After completion of conceptual studies, parallel definitions study contracts will be issued to industry in a competition for the development program. In-house and contracted supporting technology will continue to advance the readiness level in key areas. A major example of technology development is the technology mirror assembly program involving two separate approaches to grinding and polishing GFE mirror blanks to AXAF performance goals. The resulting mirror systems will undergo extensive evaluation in the MSFC X-Ray Test and Calibration Facility. Additional optical technology support tasks are being planned for FY-84 to further advance the state of readiness in this crucial area.

Oceanic Processes

W84-70430 **161-10-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RESEARCH MISSION STUDY - TOPEX
C. A. Yamarone 213-354-7141

This RTOP will define a total observational system for the measurement and monitoring of global ocean circulation by using an Earth orbiting system capable of providing dedicated high resolution altimetric measurements of dynamic ocean surface topography. Specifically, the study will include: (1) the configuration of the mission including precision orbit determination capabilities; (2) the configuration of all elements of TOPEX including sensor configuration by the appropriate implementing center; (3) the definition of the interface requirements and integration activities of the major TOPEX elements; (4) the development of a management plan, procurement strategy, and implementation schedule, and (5) the development of detailed cost information. Science and mission requirements were developed in FY-80 and finalized in FY-81. Mission and satellite concepts were assessed in FY-81 and lower cost mission and systems assessed in FY-82. Limited development of critical sensor elements were initiated in FY-83 along with a further refinement of the configuration of all systems, the management plan and procurement strategy. Phase B satellite definition studies were also initiated. A full Phase B effort will be conducted in FY-84 to prepare for a project start in FY-85.

W84-70431 **161-10-08**
Jet Propulsion Laboratory, Pasadena, Calif.
SCATTEROMETER ACCOMMODATION STUDY
F. K. Li 213-354-2849

The overall objectives of the Ocean Scatterometry Program are to conduct research leading to a better understanding of the radar backscatter/oceanic wind relationship and to obtain accurate global ocean wind field data that can be useful for oceanography and meteorology by a spaceborne scatterometer. The specific FY-84 objectives are to conduct a phase B study for the NROSS Scatterometer and to carry out an airborne experiment program leading to a better radar backscatter/oceanic wind relation that is directly applicable to the NROSS Scatterometer. In order to accomplish these specific objectives, we will continue our FY-83 activities in the design and costing of the NROSS Scatterometer sensor and ground data processing systems. We will also develop a refined implementation plan for these systems. To further our understanding of the geophysical algorithm, we will continue our analysis of SEASAT SASS data and will conduct the first of a series of airborne scatterometry experiments. The data collected over the next several years from these experiments will be used to formulate the geophysical algorithm for the NROSS Scatterometer.

W84-70432 **161-20-00**
Goddard Space Flight Center, Greenbelt, Md.
PHYSICAL OCEANOGRAPHY
D. B. Rao 301-344-4718

The objective is to conduct a variety of oceanic research activities which are important to the agency's physical oceanography program and will contribute to particular aspects of the program as they evolve. Among these activities are studies involving the calculation of geostrophic and Ekman transport from SEASAT altimetry; remote sensing of ocean circulation; ocean circulation and topography; advanced location and data collection system, and research applications of ocean data in large-scale forecasting models. Approaches to the variety of problems include the application of Goddard modeling and sensors and system development capabilities.

W84-70433 **161-20-07**
Jet Propulsion Laboratory, Pasadena, Calif.
CURRENTS AND TIDES FROM SATELLITE ALTIMETRY
M. E. Parke 213-354-2739

The objective of this research is to investigate two-dimensional mapping of altimeter data in order to separate the mean and time-varying components of the altimeter signal. The mean ocean surface is related dominantly to Earth structure and sea floor topography. The time-varying part of the altimeter signal can be related to a number of oceanographic phenomena, including tides and current topography. The approach is to utilize altimeter data at crossover points. When best knowledge of the ocean tide is removed, the resulting crossover height differences can be used to solve for the long wavelength ($>$ 2000 km) time variations in the data (dominantly due to orbit error). Removal of this estimate and interpolation results in a self-consistent estimate of the mean ocean surface. Time variations over scales of 300 km to 2000 km can be related to variations in ocean current topography over the same scales when the signal is strong enough. Without removal of an estimate of the ocean tide, the crossover differences can be used to investigate the tide. There are two regimes, shelf regions where typically amplitudes are large but lengthscales too short to be completely resolved and the deep ocean where amplitudes are much smaller but lengthscales are quite large.

W84-70434 **161-20-11**
Jet Propulsion Laboratory, Pasadena, Calif.
TIME-DEPENDENT WIND FIELDS
D. B. Chelton 213-354-7151

The objectives of this proposal are to generate and examine the geophysical parameters of wind speed, sea surface temperature, and cloud cover (integrated precipitatable liquid water) from the Nimbus-7 SMMR. In particular, the evolution of these fields over the equatorial Pacific will be examined preceding, during and subsequent to the recent 1982 El Nino event in the tropical Pacific Ocean. The approach to satisfy these objectives is to work closely with Eni Njoku at JPL in generating monthly maps of the four geophysical parameters for the time period September 1981 to February 1983. Since the algorithms to be used are only modified SEASAT algorithms and the Nimbus-7 SMMR is essentially the same as that flown on SEASAT, we are optimistic that accurate fields can be generated from the Nimbus data. Once the monthly maps are produced, analysis of the data to describe the evolution of the wind, temperature, and cloud fields will be straightforward. Present thoughts on how the 1982 event evolved (based on sometimes sparse in situ measurements) will be tested from the SMMR data.

W84-70435 **161-30-02**
Jet Propulsion Laboratory, Pasadena, Calif.
STUDIES OF OCEAN PRODUCTIVITY
M. R. Abbott 213-354-4658

The usefulness of satellite imagery of ocean color and the estimation of near-surface chlorophyll and primary productivity from such imagery will require an understanding of the effects of vertical variability in chlorophyll content and productivity and the physical and biological processes responsible for such variability. Estimation

of chlorophyll and productivity on large horizontal scales will require a similar understanding of the causes of variability, particularly over long time series. To accomplish these objectives, I propose two activities: a retrospective examination of ocean color and thermal imagery overlapping with two field programs and comparison of chlorophyll and productivity data. I will collaborate on a NASA-funded program with Dr. T. M. Powell (Univ. of Calif., Davis) and Dr. K. L. Denman (Inst. of Ocean Sciences, B.C.) to compare the spatial statistics of CZCS data with the partial statistics of chlorophyll and productivity field data derived from various vertical integration schemes. We will also compare similar statistics of the CZCS and thermal imagery. The second field program is the Coastal Ocean Dynamics Experiment (CODE) which took place off the nothern California coast in 1981 and 1982. This program was designed to study the response of coastal waters to wind forcing at 2 to 10 day time scales. The CZCS and AVHRR imagery will be used to investigate mesoscale phenomena and their relationship to physical forcing and shelf circulation. The second activity will use shipboard measurements of chlorophyll and productivity to develop relationships between near-surface chlorophyll, as measured by ships and satellites, and water column productivity. This activity is in association with Dr. R. W. Eppley (SIO).

W84-70436 **161-30-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SEA SURFACE TEMPERATURE DISTRIBUTION
D. E. Hagen 213-354-7073

Long-term research efforts will focus on characterizing the sea surface temperature variability of the California current and comparing the structure of the SST from space with in-situ data. The approach will be to conduct a formal comparison of existing algorithms for the correction of measured brightness for clouds and water vapor; to select or develop the optimum algorithm in association with JPL atmospheric scientists familiar with radiative transfer research; to see to its implementations as part of a comprehensive and verified AVHRR image processing system; and to participate as an investigator in California Current regime cruises organized by the Naval Postgraduate School.

W84-70437 **161-30-04**
Jet Propulsion Laboratory, Pasadena, Calif.
CHLOROPHYLL/TEMPERATURE TIME SERIES FROM THE CALIFORNIA CURRENT SYSTEM
M. R. Abbott 213-354-4658

Satellite images of sea surface temperature (from the AVHRR) and near-surface chlorophyll (from the CZCS) are being prepared by the Pilot Ocean Data System (PODS). A time series of images from three regions of the California Current system will be used to study mesoscale and large-scale biological and physical processes. The objectives are to understand the variability of physical processes and its relationship to physical forcing, to investigate the relationship of this variability to biological variability, and to understand the connections between mesoscale and large-scale phenomena.

W84-70438 **161-30-05**
Jet Propulsion Laboratory, Pasadena, Calif.
LIDAR AND ACOUSTICS APPLICATIONS TO OCEAN PRODUCTIVITY
D. J. Collins 213-354-3473

The objective of this research is to develop in-situ instrumentation capable of examining the vertical structure of the phytoplankton and zooplankton communities in the ocean to provide a detailed description of the three-dimensional structure of the ecological systems involved in ocean productivity. These measurements form one part of a long-term effort to monitor the productivity of the world's oceans using oceanic LIDAR from aircraft and using satellite instrumentation to provide images on a global scale. These objectives will be achieved by: (1) development of an in-situ LIDAR instrument capable of remote measurement of the fluorescence and spectral reflectance from chlorophyll and other pigments. This unit will use the water Raman return as a measure of the optical properties of the water column, and will use Raman and Brillouin scattering for the remote measurement of temperature. (2) development of a linearly frequency modulated sonar instrument capable of measuring the vertical distribution of zooplankton species in the euphotic zone. (3) development of a towed submersible that will provide a stable platform for the in-situ instrumentation and that will provide physical oceanographic data and calibration data required for these measurements.

W84-70439 **161-40-02**
Jet Propulsion Laboratory, Pasadena, Calif.
ACTIVE-PASSIVE SEA ICE ANALYSIS
F. D. Carsey 213-354-8163

Objectives of this work are to improve the observation of critical elements of the seasonal cycle of sea ice using active and passive elements data sets from space. The elements, chosen because of their strong part in basin-wide air-sea-ice interaction, are surface albedo, snowcover, and ice budget terms. The data sets examined are from SEASAT, Nimbus 7, Nimbus 5, and field studies; the data sets for which this work is in preparation are from DMSPSSM/I SIR B, SIR C, NROSS, ERS-1 and RADARSAT. The approaches are: (1) adaptation of theoretical work on snowcover monitoring by passive and active microwave including modification of published work to account for the complex grain size distribution changes with season and with depth in the pack and to account for the brine found in the snowcover on first-year ice; (2) analysis of data from past field work and planning and conduct of future field work, possibly in 1985 and 1986; (3) examination of passive and active microwave data sets using modeling of microwave behavior and climatological effects with respect to sea ice; and (4) continuation of SAR image classification research and ice velocity research using computer techniques in order to estimate ice advection, open water production, and ice ridging terms in the ice budget.

W84-70440 **161-40-03**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE REMOTE SENSING OF OCEANOGRAPHIC PARAMETERS
E. G. Njoku 213-354-5607
(161-30-03)

This RTOP describes three separate but related tasks. A workshop activity is in progress to compare and evaluate the accuracies of four satellite techniques for measuring global Sea Surface Temperature (SST). The sensors involved are the AVHRR (NOAA-7), HIRS/MSU (NOAA-7), SMMR (Nimbus-7), and VAS (GOES-East). SST data from these sensors will be obtained for common months and compared with each other and with in-situ data using facilities of the Pilot Ocean Data System at JPL. Two workshops to review the results have been scheduled for FY-83 and one for FY-84. Global-scale analyses of SMMR data from SEASAT and Nimbus-7 are being performed. These will enable the performance of the two SMMR instruments to be compared at both sensor and geophysical levels. Global maps of SEASAT SMMR geophysical parameters have been produced, and are being compared with climatological values and available surface truth. Nimbus-7 SMMR brightness temperatures and geophysical parameters will be generated from the raw data level and analyzed in a manner similar to SEASAT. Long-time-series Nimbus data sets will be used for collaborative studies in global wind analyses (D. Chelton), air-sea fluxes (T. Liu), and sea surface temperatures (SST workshop). Work is being performed on modelling of sea-ice anisotropy. The applicability of these and other models to remote sensing from space will be investigated. Data from Nimbus-7 SMMR will be processed over polar regions and studied in collaboration with F. Carsey, to investigate ice and snow emissivity characteristics and seasonal variations.

W84-70441 **161-50-00**
Goddard Space Flight Center, Greenbelt, Md.
OCEANIC RESEARCH SUPPORT ACTIVITIES
D. B. Rao 301-344-4718

The objective is to provide support for a variety of oceanic and ice research activities which are important to the agency's

program and will contribute to particular aspects of the program as they evolve. Among these activities are studies of ocean circulation, water mass processes, eddies and wave dynamics. Approaches to the variety of problems include the application of Goddard capabilities to the study of modeling problem, as well as the involving of leading researchers at institutions such as the Woods Hole Oceanographic Institution, M.I.T., and the Polar Science Center through a vigorous program of cooperative research activities. The RTOP Supports the Oceans, Ice and Climate Programs and the end objectives of understanding, predicting and managing the environment.

W84-70442 **161-50-02**
Jet Propulsion Laboratory, Pasadena, Calif.
SEASAT MAPS, LIBRARY, AND JGR ISSUE
D. B. Lame 213-354-4469

This RTOP has two tasks. The first has the coal of eventually producing an Atlas of SEASAT SASS, SMMR, and ALT data. The second task provides an Oceanic Remote Sensing Library. The JGR issue task was completed in the previous year. The SEASAT map task will complete the characterization of the SASS data in the various modes and then attempt to 'normalize' the data. Also, this task will attempt to determine the spatial wave number spectra of the wind speeds in several ocean basins and to determine if there is an apparent wind speed gradient across the major current systems. M. H. Freilich and D. B. Chelton will provide scientific guidance for this task. The library task will expand the collection of reference books, atlases, journals and other oceans remote sensing literature. The bibliography will be expanded and the PODS remote users will be supported.

W84-70443 **161-50-03**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN PROCESSES BRANCH SCIENTIFIC PROGRAM SUPPORT
M. T. Chahine 213-354-2433

The objective of this task is to support the NASA Oceanic Processes Branch in the development and use of remote sensing techniques to study physical and biological oceanic processes and their interactions with the atmosphere.

W84-70444 **161-50-04**
Jet Propulsion Laboratory, Pasadena, Calif.
ERS-1 PHASE B STUDY
C. F. Winn 213-354-8185

This RTOP covers a study for the acquisition and processing of the Synthetic Aperture Radar (SAR) data from the European Space Agency ERS-1. The data from the SAR will be processed on the ground into images for sea ice, ocean and Earth resources research in Alaska. The science planning for both sea ice, ocean research and Earth resources research will be started. A ground site is required in Alaska to receive and record the wide band SAR data. The requirements for the ground station will be generated and tradeoff studies between a new system based on a modified LANDSAT ground station and modifying the current 26 m station will be done. The methods of antenna pointing for the 26 m station must also be studied. The received SAR data will be shipped to JPL for ground processing the Advanced Digital SAR Processor (ADSP). A small amount of data will also be processed in near real time on site for polar ice research in connection with shipping operations. Preliminary science plans will be made to allow complete system specifications and plans to be generated. The antenna pointing trade-off studies which include open loop vs. close loop with a number of close loop options will be done for the modification of the 26 m station. Class A cost will be developed for both the modified station and a new station based on a LANDSAT-D design. Class A estimates will be generated for the rest of the system. The above will be complete in the first 6-months of FY-84. The remainder of the year will be used in detail planning of the science activities and system design.

W84-70445 **161-50-05**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECIAL PROJECTS WITHIN THE PILOT OCEAN DATA SYSTEM
J. C. Klose 213-354-5036
(656-13-40)

The objectives of this RTOP are to: (1) develop a Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I) processing, archiving, and data distribution system for the sea ice research community; (2) provide support to researchers that are producing color and temperature time series for later archiving and distribution by the Pilot Ocean Data System (PODS); and (3) upgrade the SEASAT altimeter geophysical data record (GDR) to include improved orbit and oceanic model parameters, and correct known deficiencies in the existing GDR. These objectives will be pursued through the use of PODS facilities and staff. Ocean researchers from JPL and other institutions will participate in these activities to ensure that the data products produced are suitable for their needs and of the highest quality possible.

W84-70446 **161-80-00**
Goddard Space Flight Center, Greenbelt, Md.
AIR/SEA INTERACTION STUDIES
D. B. Rao 301-344-4718

The objective is to conduct a variety of oceanic research activities which are important to the agency's physical oceanography program and will contribute to particular aspects of the program as they evolve. Among these activities are studies involving the Microwave Radar Oceanography, Microscale Ocean Surface Dynamics, A Surface Contour Radar for Ocean Wave Studies, and Large-Scale Air-Sea Interaction Forecasting. Approaches to the variety of problems include the application of Goddard modeling and sensors and system development capabilities. The RTOP supports the Oceans Program and the end objectives of understanding, predicting, and managing the environment.

W84-70447 **161-80-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RADAR STUDIES OF THE SEA SURFACE
R. H. Stewart 213-354-5079

The usefulness of satellite data depends to a great extent on the degree with which the user community understands satellite measuring techniques, their accuracies, and their applicability. To contribute to this understanding, a small amount of time will be spent working with the University of California Press to complete the editing of the book "Methods of Satellite Oceanography". There will be close collaboration with Michael Freilich to investigate the accuracy of scatterometer measurements of wind speed, the dominant sources of error, and the relationship between radar scatter and wind stress, and to plan experiments necessary to investigate these relationships. The development of techniques for measuring oceanic rainfall remotely is hampered by a lack of accurate means for calibration. Rain gauges on ships are notoriously inaccurate, and airborne radars are expensive and not sufficiently developed to yield accurate measurements. Noise produced by rain falling on the sea should offer a new method for calibrating rain rate. A graduate student working at the Scripps Institution of Oceanography, J. Nystuen, has measured rain noise in a tank, in a small lake, and in the sea, and finds a useful correlation between noise and rain rate. This work will continue to be supervised, and funded through a subcontract to the Scripps Institution of Oceanography.

W84-70448 **161-80-03**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEANOGRAPHIC SEASAT DIGITAL SAR PROCESSING
T. A. Andersen 213-354-3964
(677-48-01)

The objective of this RTOP is to process SEASAT radar data to produce synthetic aperture radar images of ocean/ice areas in support of ocean resource investigations. The processing will be performed using the upgraded interim Digital Processor (IDP) in

JPL. Each image will exhibit a 25 meter resolution and cover a 100 km square target area. At least 20 images will be produced in FY-84.

W84-70449 **161-80-15**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING OF AIR-SEA FLUXES
W. T. Liu 213-354-2394

The objective is to examine, with the help of satellite observations, the momentum and latent heat exchanges between the tropical Pacific Ocean and the atmosphere. The first two years of study consist of the development and implementation of remote sensing techniques for estimating low frequency latent heat flux over the tropical Pacific. Radiosonde soundings from selected stations will be examined to establish a relation between the integrated atmospheric water vapor (as observed by satellite sensors) to the near surface humidity. High quality in-situ measurements from moored and drifting sensors of the Tropic Heat experiment will be used to compare with satellite observations and to evaluate bulk parameterization methods. The satellite products, in turn, will provide the much needed information at relevant scales for the study of the evolution of surface water in the tropical Pacific.

Solar Terrestrial Theory Program

W84-70450 **168-05-01**
Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLE ACCELERATION IN SOLAR SYSTEMS PLASMAS
R. Ramaty 301-344-8715

The objectives are: (1) to study the acceleration of energetic particles in the solar system; (2) to publish in the scientific literature and to present at professional meetings the significant results of such research; and (3) to collaborate with and support theoretical research of graduate students, research associates, coinvestigators from other academic institutions who work on the subject matter of the RTOP.

Solar Terrestrial ATD Advanced Mission Studies

W84-70451 **171-03-00**
Goddard Space Flight Center, Greenbelt, Md.
ORIGINS OF PLASMAS IN THE EARTH'S NEIGHBORHOOD (OPEN) PROJECT
Kenneth O. Sizemore 301-344-5108

The objective of this RTOP is to develop the scientific and technical basis for a Solar Terrestrial multisatellite mission proposed for flight in FY-89-90. The objective of this mission is to provide simultaneous, coordinated measurements of the role of plasmas in the transport, storage, and dissipation of energy in the solar wind and the terrestrial magnetosphere. The approach is to conduct system design studies in the areas of sensors and/or instrument requirements design, mission analysis, space segment and system definition and design, and ground processing systems to meet requirements established by the Solar Terrestrial Program Office and its appointed Science Working Group.

Severe Storms and Local Weather Research

W84-70452 **175-13-00**
Goddard Space Flight Center, Greenbelt, Md.
SEVERE STORMS AND LOCAL WEATHER
J. Simpson 301-344-8569

The objectives are to: (1) utilize space observations to improve understanding, diagnosis, and predictability of severe atmospheric storms (tropical and mid-latitude); (2) develop analysis and interpretation techniques using data from satellites in combination with other sources; (3) adapt subsynoptic and storm scale numerical models to use satellite and conventional data; (4) simulate impact of satellite measurements on severe storm analyses and predictions; and (5) formulate requirements for future satellites to improve severe storm diagnosis, warnings, and predictions of local and mesoscale weather events. Quantitative methods will be developed to utilize satellite data in predictive models, diagnostics, and nowcasting. The scientific accuracy and usefulness of VAS geosynchronous soundings will continue to be tested and evaluated. Case studies will be conducted utilizing AOIPS to synthesize data sets, often with model output, to improve physical understanding and predictive capability. Combined satellite, remote aircraft, and in-situ data sets will be obtained from participation in joint field programs. Numerical storm-scale, subsynoptic scale models will be adapted to use satellite data in initialization, model improvement, and data interpretation.

W84-70453 **175-20-00**
Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF NEW REMOTE DATA INTERPRETATION TECHNIQUES
W. W. Vaughan 205-453-3100

The objective of this RTOP is to contribute to the NASA Mesoscale Processes Research program by conducting applied research and development activities using space-related techniques and observations that will increase the basic understanding of storms and mesoscale phenomena. Utilizing the talents of university and private contractor groups, plus the MSFC in-house talents and laboratory capabilities, specific research activities will be accomplished.

W84-70454 **175-50-00**
Marshall Space Flight Center, Huntsville, Ala.
MESOSCALE PROCESSES RESEARCH SUPPORT
W. W. Vaughan 205-453-3100

The objective of this RTOP is to contribute to the NASA Mesoscale Processes Research Program by conducting applied research and development activities using space-related techniques and observations that will increase the basic understanding of storms and mesoscale phenomena. Utilizing the talents of university and private contractor groups, plus the MSFC in-house talents and laboratory capabilities, specific research activities will be accomplished.

Tropospheric Air Quality

W84-70455 **176-10-00**
Goddard Space Flight Center, Greenbelt, Md.
GLOBAL TROPOSPHERIC MODELS
R. S. Steward 301-344-8895

The objective of this RTOP is to develop an understanding of tropospheric environmental problems that may be amenable to solution through the use of remotely sensed data; assess the impact of urbanization and industrialization on global, regional, and urban air quality; and develop, evaluate, and demonstrate remote sensing concepts for observing the nature and distribution of tropospheric pollution. The development of global tropospheric models for calculation of tropospheric trace species concentrations will be continued. Physical processes will be described in one and two dimensional models and satellite methods of monitoring air pollution will be monitored. In addition, airborne lidar for OH and NO measurements will be developed.

W84-70456 **176-20-01**
Ames Research Center, Moffett Field, Calif.
CV-990 METEOROLOGICAL MEASUREMENT SYSTEM (MMS) DEVELOPMENT
K. R. Chan 415-965-6263
(147-10-03)

The objectives are to develop special instrumentation and to equip the CV-990 aircraft with in-situ, fast response, and high resolution thermodynamics and air motion measurement capabilities. These measurement capabilities are essential in the Global Tropospheric Experiment under the Tropospheric Air Quality Program. The approach is (1) to develop a special air motion subsystem in lieu of the conventional nose boom sensors; (2) to develop a dedicated data acquisition subsystem; (3) to procure a high resolution inertial navigation subsystem; and (4) to develop algorithms for computations and data processing. The three subsystems will be integrated, tested, and calibrated in FY 84.

W84-70457 **176-20-16**
Ames Research Center, Moffett Field, Calif.
TROPOSPHERIC MEASUREMENT OF CO
E. Condon 415-965-6071
(176-20-13; 176-20-01)

The primary objective of this program will be to characterize the distribution of carbon monoxide and methane in the Earth's lower atmosphere as a function of altitude, latitude, and season. Obtaining information on the behavior and variability of trace gas species in the atmosphere will aid in understanding the natural atmospheric chemical processes. Quantifying the concentrations of trace gases and radicals in the atmosphere under varying meteorological conditions will better define tropospheric photochemistry and permit an assessment of the impact of anthropogenic emissions and alterations on the natural chemical processes and climate. Samples will be collected as a function of altitude on the CV-990 for vertical profile information at sites specified by the GTE program. The samples will be returned to the laboratory for analysis by gas chromatography whereby measurements of the CO and CH4 concentrations will be made. The data collected will serve to describe the concentration profiles of these trace species and will be correlated with the meteorological data set obtained as part of the experiment. The CO and CH4 data will also serve as input to calculations of the OH radical concentration and thus aid in verifying the measured OH values.

W84-70458 **176-30-01**
Jet Propulsion Laboratory, Pasadena, Calif.
KINETIC STUDIES INVOLVING CH3O2, HO2 AND IO RADICALS OF TROPOSPHERIC IMPORTANCE
S. P. Sander 213-354-2625

A program of laboratory studies will be conducted to measure key rate constants for reactions of hydroperoxyl (HO2), methylperoxy (CH3O2), nitrate (NO3) and iodine oxide (IO) radicals. The goal of this program is to improve and enlarge the kinetics database for reactions of tropospheric importance involving these radicals. The experimental approach will be to utilize the techniques of flash photolysis, discharge flow-mass-spectrometry and Fourier transform infrared spectroscopy.

W84-70459 **176-40-00**
Wallops Flight Center, Wallops Island, Va.
IMPROVED AIRCRAFT NOX INSTRUMENT
A. L. Torres 804-824-3411

The objectives of this effort are to develop an instrument system to accurately measure atmospheric concentrations of NO(x) at pptv levels, and to demonstrate the capability of this technique to support the Global Tropospheric Experiment requirements for airborne operations in remote, clean areas of the troposphere. These objectives will be met by first developing a high-sensitivity NO detector, based on the chemiluminescent NO/03 reaction. This will be accomplished through extensive redesign and modification efforts on an existing medium-sensitivity instrument already having a considerable aircraft history. The projected detection limit for the new system is about 3 pptv for a one-second integration. A chemical conversion technique for measuring NO2 by converitng it to NO will then be evaluated. Finally, the performance of the system will be throughly tested in a series of Global Tropospheric Experiment instrument intercomparisons, starting on the ground and proceeding to aircraft test flights under varied environmental conditions.

W84-70460 **176-40-03**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF RESONANT IONIZATION LASER SPECTROSCOPY FOR TROPOSPHERIC NOX MEASUREMENTS
J. B. Laudenslager 213-354-2259
(506-54-45; 506-61-75)

The objectives of this work are to develop a sensitive and selective in-situ measurement technique, resonant ionization laser spectroscopy, for tropospheric NO(x) measurement; extend the measurement capabilities, in subsequent years, to other important tropospheric molecules; and propose follow on funding for field measurements of tropospheric NO(X) from ground and aircraft platforms after confirmation of this technique from the preliminary laboratory studies. The resonant ionization laser spectroscopy detection of NO(x) will first be demonstrated in the laboratory using commercial dye laser systems to identify laser wavelengths, pulse energies, and repetition rates required for field measurement of NO(x) in the parts-per-trillion range. Computer simulations and results of peliminary experiments of the resonant ionization technique indicate that sensitivity for both NO and NO2 of a part-per-trillion with small error limits is feasible. The field measurements for NO(x) will require compact, tunable, high pulse energy ultraviolet laser sources at selected wavelength regions. We plan to develop tunable ultraviolet excimer lasers for this application, and this excimer laser construction will be co-funded by an OAST-supported program for laser development. The successful development of the resonant ionization laser spectroscopy detection method for tropospheric species will enable concentration measurements of several chemically coupled trace species to be made simultaneously with potentially smaller error limits than have been possible with other measurement techniques. Simultaneous measurement of NO, NO2, O3, OH and jNO2 are particularly important for tropospheric chemical models to characterize the sources and sinks of tropospheric ozone.

Space Processing Applied Research and Data Analysis

W84-70461 **179-10-10**
Lewis Research Center, Cleveland, Ohio.
MATERIALS SCIENCE IN SPACE (MSS)
F. J. Kohl 216-433-5266

The overall objectives of this effort are to: (1) achieve a basic understanding of the role of gravity in the fundamentals of materials science and processing; and define areas of potential applications for low-gravity processing using Earth-based or space facilities. Emphasis will be placed on the disciplines of materials science, fluid physics, metallurgy, inorganic and organic chemistry, and high temperature chemistry. Specific thrusts in the FY-84 program will be in the areas of solidification fundamentals, electronic materials, and ceramics (RTOP Part A) and transport processes, thermo/diffusocapillary flow, and interfacial fluid dynamics (RTOP Part B). The general approach is to conduct both experimental and theoretical research on fundamental materials phenomena in order to define governing mechanisms, validate models, and obtain unique data unavailable to date because of the limiting and masking effects of gravity. A five-fold effort will be employed: (1) a materials science experiment definition effort will be conducted in collaboration with the academic and scientific communities; (2) experimental and/or theoretical research projects will be carried out in selected areas utilizing materials research laboratories and the available ground-based reduced gravity facilities; (3) a MSS Working Group will be formed to review and assess the program; (4) experimental conceptual designs shall be prepared and experiment apparatus

and instrument definition activities shall be conducted, and (5) ground-based hardware definition studies will utilize bench-testing, drop towers, and aircraft facilities where flight hardware will be developed for space experimentation. These efforts shall include fabrication of experiments which can be conducted aboard the STS.

W84-70462 **179-13-72**
Lyndon B. Johnson Space Center, Houston, Tex.
BIOPROCESSING STUDIES
Dennis R. Morrison 713-483-5281
(694-01-01)

The objectives of this effort are to provide biological expertise (cell handling, cell culture, cell separating and bioassays) and to perform flight experiments in support of the Materials Processing in Space Program. The JSC Bioprocessing Laboratory will coordinate the tissue culture, bioassays and cell characterization phases of projects with MSFC, university based investigators, McDonnell Douglas Astronautics Co. and NASA Hqs. Emphasis is currently placed on cell culture, ground-based cell separation techniques, and NASA flight tests using the MDAC Continuous Flow Electrophoresis System (CFES) under the NASA/MDAC Joint Endeavor Agreement. Procedures to achieve maximum cell viability and growth before and after electrophoretic separations and assays for cell products will be developed. The limitations of ground-based cell culture will be evaluated and the advantages of culturing mammalian cells under weightless conditions will be identified and demonstrated by flight tests of small prototype culture systems.

W84-70463 **179-14-20**
Jet Propulsion Laboratory, Pasadena, Calif.
GLASS RESEARCH
Michael C. Weinberg 213-354-2690

The overall objective of this RTOP is to obtain both fundamental and practical information pertaining to the preparation and processing of glasses in a space environment. These studies will establish a quantitative scientific basis for containerless experiments with glass forming materials. The work in FY 84 will continue our studies of gel derived glasses, of nucleation and crystallization of glasses, and of gas bubble behavior in glassmelts. The objectives for FY 84 are to: (1) Study the surface crystallization of fluoride and silicate glasses. (2) Study homogeneous nucleation in simple inorganic glasses. (3) Assemble apparatus and perform preliminary experiments of gas bubble dissolution in glass melts and compare results with theory. (4) Study the structure and kinetics of the early stages of phase separation of gel glasses. (5) Study the formation and characterization of gel monoliths. (6) Study the characteristic behavior and properties of gel glasses.

W84-70464 **179-15-20**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTIMODE ACOUSTIC RESEARCH
Martin Barmatz 213-354-3088
(179-13-20; 170-50-20)

This RTOP will provide fundamental research support for the "Advanced Containerless Processing Technology" program. New classes of acoustic levitation have been discovered at JPL in rectangular, cylindrical and spherical geometries that may be attained by the excitation of multidimensional acoustic modes (multimodes). These new levitation principles provide us with advanced alternative methods for positioning and manipulating molten materials, which may lead to rapid cooling, separation of levitation and rotation capabilities, and the selection of arbitrary axes of rotation. The long term objectives of this RTOP are to develop theoretical acoustic models of these levitation classes and to provide experimental validation of these models using research levitation devices. The FY 84 activities will continue to develop a more fundamental understanding of these acoustic levitation properties. The objectives for FY 84 are to: experimentally study levitation properties of spherical and long cylindrical chambers; and to develop theoretical expressions for stable levitation positions in the presence of acoustic and external fields. As these new, versatile techniques are verified, they will be incorporated into the "Advanced Containerless Processing Technology" program.

W84-70465 **179-20-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CONTAINERLESS PROCESSING SCIENCE AND TECHNOLOGY
T. G. Wang 213-354-6331
(179-20-57; 179-20-56)

The long range objectives of this task are to: study and advance the science of contactless positioning and manipulation in a high temperature acoustic containerless processing chamber; study the undercooling and nucleation phenomena in containerless processing facilities; provide technical assistance to the Acoustic Containerless Experimental System (ACES) engineering team; develop a set of precursor high temperature material processing experiments to be conducted in early ACES flights; and provide overall management support of Material Processing in Space (MPS) program at JPL. Under this RTOP, all aspects of high temperature containerless processing will be studied. The principles of operation, the characteristics of the performance, the advantages of the containerless experiment, and the feasibility of hybrid systems will be established. The primary subjects to be addressed in FY-84 are experimental and theoretical studies of: (1) acoustic positioning and manipulation capabilities in a uniform temperature gradient environment (from 25 C to 900 C); (2) acoustic positioning capability and sample stability in a non-uniform temperature gradient acoustic chamber; (3) characteristics of acoustic parameters, such as waveform, harmonic content, sample stability, power transfer, and radiation force in high temperature gradient systems; (4) undercooling and nucleation temperatures of molten drops of tin, Al, and other materials; and (5) KC-135 tests of an active position feedback system so as to reduce acceleration forces and minimize position error.

W84-70466 **179-20-56**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTROSTATIC CONTAINERLESS PROCESSING TECHNOLOGY
D. D. Elleman 213-354-5182
(179-20-56; 179-20-57)

The long range objective of the Electrostatic Task is to develop the science and technology base that is required for contactless positioning and manipulation of high temperature materials using electrostatic and electrophoretic forces. An Electric Field Containerless Processing Module (EFCPM) operating at room temperature has been demonstrated in FY-83. The successful demonstration of the room temperature EFCPM and the results from the high temperature charge loss studies will lead to the design and development of a high temperature facility and flight models of the EFCPM. Preliminary tests in a neutral buoyancy tank using electrophoretic forces rather than electrostatic forces have been conducted. This technique promises improved performance at high temperatures where charge loss could be a problem for the electrostatic method. This program will include both theoretical and experimental investigations as well as reduced gravity tests of the module on the KC-135 aircraft. In conjunction with the Electric Field Positioning Science Working Group, the definition of potential MPS flight experiments utilizing the EFCPM will be given the highest priority in FY-84. Objectives to be addressed in FY-84 include low gravity tests and neutral buoyancy test of both the room temperature electrostatic module and the electrophoretic model. Both high density solids and liquid samples to simulate molten samples will be used in the test program. The ground based high temperature electrostatic model will be used to measure charge loss and charge transfer at elevated temperatures.

W84-70467 **179-20-57**
Jet Propulsion Laboratory, Pasadena, Calif.
SPHERICAL SHELL TECHNOLOGY STUDY
T. G. Wang 213-354-6331
(179-20-55)

The overall objective of this proposed work is to study the

science and technology associated with spherical shells and the effect of gravitation on the formation of spherical shells both in the laboratory and in a weightless environment. The technology being developed rests upon the disciplines of fluid-dynamics of viscous media, the rheology of liquids near their solidification temperatures, and the physics of metallic and amorphous materials. These are applied to processes for shell fabrication, for rendering the shell spherically symmetric, and to the technology of applying multilayer coatings to the interior and exterior surfaces. The long range objectives of this task are to: (1) study the fluid mechanics relevant to the production of spherical shells such as drop sphericity, bubble centering and jet stability both in the laboratory and in a weightless environment; (2) study the gravitational effects on the dynamics of liquid bubbles and determine the optimum methods of circumventing these limiting factors imposed on the experiment by the coupling of time, gravity and temperature; (3) develop the technology that is pertinent to the production of glass, metallic and metallic glass shells of various dimensions and aspect ratios; (4) develop and construct high temperature and high cooling rate facilities that are needed to produce refractory metallic and metallic glass spheres; (5) develop and construct high pressure drop tower facilities that are needed for prefilling the shell with desired gases and pressure; (6) develop technology applicable to the production of a novel high strength low weight material by bonding of the spheres; and (7) develop technology needed for the encapsulation of various materials within the spherical shell, such as the phase change materials for best heat regeneration.

W84-70468 **179-40-62**
Jet Propulsion Laboratory, Pasadena, Calif.
MATERIALS PROCESSING PROGRAM SUPPORT
T. G. Wang 213-354-6331
(179-10-62)

The objective of this RTOP is to develop and implement program plans for the Materials Processing in Space Program. These plans will provide the guidance for initiating ground based experiments to develop a data base for future planning of space operations. JPL has already been working on the first phase of this plan and the effort will be expanded to include university participation. Coordination of the effort will be provided by a detailee from JPL assigned to NASA Headquarters, Office of Materials Processing in Space.

W84-70469 **179-40-62**
Marshall Space Flight Center, Huntsville, Ala.
MPS AR&DA SUPPORT
J. R. Williams 205-453-1872

The objectives of this RTOP are to provide the necessary management and support manpower to implement the MPS research and technology development effort; and to provide the MPS program with an effective means of interacting with the various scientific communities involved for the purpose of: (1) making them aware of the research opportunities offered by the MPS program; (2) stimulating their interest and active involvement in the program; (3) gauging their response to the scientific results being obtained by the program; (4) identifying research areas in which the program should concentrate; (5) initiating in-house research activities in selected topics pertinent to the MPS program; and (6) evaluating the ongoing research effort. The MSFC will ensure the necessary professional and supporting manpower to implement the MPS research and technology development effort. Also, the stated objectives will be met by actively involving the various research communities in the MPS program through working groups, seminars and workshops, science reviews, and a visiting scientist program. In addition, scientific goals and accomplishments of the program will be documented and disseminated to the science communities in the form of a published bibliography and catalog of tasks.

W84-70470 **179-46-20**
Jet Propulsion Laboratory, Pasadena, Calif.
RESEARCH ON THE USE OF SPACE RESOURCES
R. A. Boundy 213-354-4299

The objective of this RTOP is to develop an understanding of the basic physical properties and principles which control the rates and the practicality of candidate extraterrestrial materials processes. That understanding will allow objective decisions to be made regarding processing and use of extraterrestrial materials in space. It will also provide the technical foundation for a development program when a decision is made to proceed with utilization of space materials. The specific objective for FY-84 is to extend the FY-83 effort in evaluating the feasibility of candidate processes. Emphasis will be placed on the two oxygen-metal separation processes: magma electrolysis and vapor phase separation. A continuing goal is to quantify, through experiment, the process efficiency with respect to oxygen yield. The approach for FY-84 will be to concentrate on the oxygen-metal separation processes, namely magma electrolysis and vapor phase separation. Experimentation will be emphasized together with a close working relationship with the related research effort of Purdue University. Efforts will continue towards quantifying process efficiency especially regarding production of oxygen. Minimal depndency on consumables (e.g., reducing agents and fluxes) will continue to be emphasized.

W84-70471 **179-60-62**
Marshall Space Flight Center, Huntsville, Ala.
COMMERCIAL MATERIALS PROCESSING IN LOW-GRAVITY
R. L. Brown 205-453-4880

The overall objective of this RTOP is to foster commercial uses of Materials Processing in Low-Gravity (MPLG) technology in ways which will lead to new or improved processes/products on Earth and in space, and thus to benefits for the general public. The overall approach involves working directly with private and select federal organizations to stimulate interest in MPLG and lay the groundwork for use of MPLG in ways which will benefit the public. Due to the embryonic nature of MPLG technology at this time, an in-depth working relationship must be established with interested organizations wherein they can develop an understanding of how MPLG technology can meet their specific needs. Also, the factors which influence the development of an infrastructure to support an MPLG industry segment must be understood. This RTOP provides for developing an understanding of the technical and institutional issues which influence technological innovation based on MPLG technology.

W84-70472 **179-70-62**
Marshall Space Flight Center, Huntsville, Ala.
SYSTEMS DEFINITION AND ADVANCED TECHNOLOGY DEVELOPMENT
J. R. Williams 205-453-1872

The primary emphasis of this RTOP is to reduce the technical and programmatic risk of new hardware systems through resolution of technology and design problems before initiation of the hardware new starts. The implementation is through the development and testing of breadboards of sufficient fidelity that the Phase B effort is a matter of packaging the systems for flight and developing the attendant programmatic data. Fortunately, many of the apparatus design solutions will have multiple applications and will crosscut several areas of technology, so there is an efficiency to be gained by doing several of the equipment developments together.

W84-70473 **179-70-62**
Lyndon B. Johnson Space Center, Houston, Tex.
CONCEPTUAL DEFINITION OF A MANNED SPACE STATION RESEARCH DEVELOPMENT AND ENGINEERING (RD&E) FACILITY FOR MATERIALS PROCESSING/SCIENCE IN SPACE
K. J. Demel 713-483-3155

The objective is to develop a sound and rational development and implementation approach for a cost effective use of manned RD and E in the generation of a manned space station research and development laboratory facility which would expedite and

enhance the deployment of commercial materials manufacture in space with attractive return on investment. This RTOP's purpose and approach is to development the theory of the discipline of man/machine mix in material processing RD and E in Earth and space labs, to identify and develop the attributes of man which would enhance the research and development of processes of new materials in space, and develop suitable small scale facility prototype of that role for near-time deployment on the mid-deck of the STS. The prototypes would be comprised of a selection of support lab preparation and test instruments and the apparatus to process biological materials (electrophoresis), metals (furnances), containerless materials (levitation devices) and other important classes of substances which will benefit from the zero-g environment. The models would lead in the future to large scale, general purpose RD and E facilities in space with both zero-g and sub one-g environment which can be exploited by paying customers for timely and expeditions development of new materials and processes with acceptable commercial return on investment. From that juncture, efforts that are more appropriate as free-flyers and are suitable to automation could be spawned; those that remain more suitable to the man-lab environment could continue, and the mechanism would remain to start new work in new areas.

W84-70474 **179-80-30**
Lyndon B. Johnson Space Center, Houston, Tex.
HIGH-TEMPERATURE, CONTROLLED REDOX ACOUSTICAL LEVITATOR SYSTEM
Richard J. Williams 713-483-4464

The objective of this effort is to continue to design, develop, and test a high temperature acoustical containerless melting system in which oxidation-reduction conditions can be controlled, freely manipulated, and measured. The work will be focused on the production of a laboratory prototype and test of that prototype with iron-bearing silicate melts. The objective will be approached by a combination of in-house and contracted research. We will contract the development of a prototype levitator, furnace, and enclosure, and the definition of basic operating characteristics. Our in-house work will involve the design and construction of the gas mixing, control and monitoring system. We will perform the integration and the testing and evaluation of the system. Testing will take the form of a study of nucleation in silicate liquids as induced by changes in redox conditions.

W84-70475 **179-80-30**
Marshall Space Flight Center, Huntsville, Ala.
CONTAINERLESS PROCESSING
J. R. Williams 205-453-1872

The objectives of this activity are to: (1) explore novel techniques and applications for containerless processing of glases and refractory materials; (2) understand the limitations imposed by the gravitational field; and (3) evolve meaningful flight experiments which extend processes beyond gravity limitations. Containerless processing in space requires low level levitation forces to compensate for microgravity acceleration and maintain position of the sample. The central reason is the elimination of extraneous effects from contact with solid containment walls. The implementation of appropriate experiments will involve the following: (1) a 31-meter drop tube at MSFC provides 2.6 seconds of free fall for solidifying molten droplets up to several mm diameter; (2) a single axis acoustic levitator has been developed which uses a high-Q drives with a single resonant frequency; (3) a three-axis acoustic levitator has also been under development involving three mutually orthogonal drivers which produce a three dimensional sound field (spherical energy well) in a tuned cavity; (4) a 10 kW electromagnetic levitator facility, which by careful coil design maximizes Grad B/B, is in use to levitate samples with a minimum of heating; and (5) aerodynamic levitation using a jet of air from a carefully designed nozzle has been used to suspend highly reactive samples.

W84-70476 **179-80-40**
Marshall Space Flight Center, Huntsville, Ala.
BIOSEPARATION PROCESSES
J. R. Williams 205-453-1872

The long-range objective is to utilize the environment of space to separate and purify biological products. The intermediate objectives are to develop the required technology and to expand the base of knowledge involved with processing biologicals in space; to identify, evaluate and select the most promising processes; and to explore new areas of separation technology. Separation and purification procedures which have been found to produce inadequate results on the ground because of gravity-dependent problems will be evaluated and investigated. More specifically, this program will: (1) determine possible advantages of the low-gravity environment for separation and characterization of biomedical materials; (2) design and conduct experiments in space; (3) apply ground/flight knowledge to the improvement of bioprocessing procedures on Earth; (4) develop broad and strong collaborative interactions with researchers; and (5) identify and explore new techniques of separation or bioprocessing that might be enhanced by low gravity.

W84-70477 **179-80-51**
Lewis Research Center, Cleveland, Ohio.
REDUCED GRAVITY COMBUSTION SCIENCE
Thomas L. Labus 216-433-6233

The objective of this effort is to conduct ground-based research, develop theoretical models, and refine experimental techniques in conjunction with reduced gravity combustion science experiments, to be flown within the STS. Work in this RTOP will include an assessment of the science definition activities by a group of recognized experts. Activities will also include analysis of data obtained from space and preparation of technical reports. This program will consist of research conducted by scientists whose areas have been successfully peer reviewed in support of the on-going flight hardware developmet activities. The LeRC will provide the technical and management support to direct all contract and grant activities and provide coordination between government groups, contractors, and the scientific community associated with this effort.

W84-70478 **179-80-60**
Marshall Space Flight Center, Huntsville, Ala.
SOLIDIFICATION PROCESSES
J. R. Williams 205-453-1872

Control of the solidification of metals and alloys is keyed to gravitational effects such as buoyancy-driven convection. Thus, the objectives of the study are to: (1) identify various aspects of solidification phenomena that may be affected by gravity-driven flows; (2) devise and conduct critical experiments in both increased gravity as well as in space, and (3) impact the field of metallurgy by fundamental knowledge through devising better control strategies. Multicomponent metallic systems involve a first-to-freeze component which nucleates and begins to grow, causing the composition ahead of the solidification front to change dramatically. Where it is infeasible or undesirable to provide controlled gradients for a planar solidification problems invovled in the formation of dendrites. Directional solidification affords a degree of control because an unidirectional thermal gradient can be imposed and growth rate regulated. Another important class is the monotectic alloys which have a region of immiscibility. Finally, nucleation and rapid solidification of deeply undercooled melts will be pursued by containerless melting and solidification.

W84-70479 **179-80-70**
Marshall Space Flight Center, Huntsville, Ala.
CRYSTAL GROWTH PROCESSES
J. R. Williams 205-453-1872

In any crystal growth system, an important problems is that the compositional and/or thermal fluctuations in the fluid phases cause compositional inhomogeneities and defects in the growing crystal. Where these fluctuations are caused by convection and sedimentation, they can be reduced in low gravity. Therefore, the major objectives of this crystal growth program are to: (1) understand the role of gravity and determine limitations in Earth's gravity; (2) determine and demonstrate advantages to be obtained by growing crystals in space; and (3) apply the findings to help

solve problems in the growth of electronic and detector crystalline materials. The types of growth that will be explored in this program include melt, solution, vapor, and float zone growths. Crystal growth by solidification from the melt is the most widely used technique for high technology single crystalline materials. The success of the technique depends on the control of the composition, temperature, and morphology of the solidification interface. Advantages of this technique include the control it provides over the temperature of growth and viscosity. In the vapor approach, there are two distinct mechanisms for growing a crystal: (1) the physical vapor deposition and (2) chemical vapor deposition (CVD). Finally, floating zone crystal growth is accomplished by supporting a polycrystalline rod at both ends; melting a portion of it with a moving heater, and growing a crystal behind this zone.

Solar Terrestrial and Astrophysics SR&T

W84-70480 **188-38-51**
Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF SOLAR EXPERIMENTS AND HARDWARE
Robert D. Chapman 301-344-6184

The objective of this RTOP is to develop scientific instruments which contribute to the solution of well-defined solar research problems. These activities have the ultimate objective of flying payloads on problem-oriented missions. These research programs will form the basis for missions using the shuttle or free fliers. One of these will be a study of coronal structures contributing to the solar wind and the interplanetary plasma. The sources of high energy particles of the Sun will be studied emphasizing instrumentation not accommodated by SMM and/or supplementry to the SMM instruments. All instruments will operate with the same temporal and spatial resolution to the maximum possible extent. The instruments considered for these payloads are: EUV and soft X-ray spectroheliographs and spectrographs for observation of structures in the corona and active regions with 1 arc sec spatial resolution and spectral resolution down to 10 mA; and high-resolution X-ray and gamma-ray telescopes. In general support of the programs for instrument development is the investigation of critical optical components for ultraviolet and soft X-ray wavelength studies. This covers: the design, fabrication, and testing of aspheric optical surfaces for Wolter Type-II grazing incidence telescopes, extended definition studies for future solar instrumentation, and evaluation of new optical and detector technologies that may be applicable to future solar EUV and X-ray observations.

W84-70481 **188-38-52**
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED OBSERVATIONS OF THE SUN
Jan M. Hollis 301-344-7591

The major objectives of this program are: (1) to obtain and analyze observations of solar velocity and magnetic fields, global oscillations and wave motion, coronal holes, active regions and flares, etc., at wavelengths observable from the ground which complement UV, EUV, X-ray, and gamma-ray experiments on NASA flight missions such as the Solar Maximum Mission (SMM); (2) to support operational planning for spacecraft experiments; (3) to conduct basic research and develop specific instrumentation and observational progress relevant to objectives for future flight missions; (4) to analyze comet tail photographs to determine the velocity field of the solar wind; and (5) to analyze comet tail photographs to determine the three dimensional structure of interplanetary sector boundaries caused by the solar magnetic field. The vacuum telescope at Kitt Peak National Observatory is supported by the Laboratory through its Southwest Solar Facility. High-resolution, full-disk magnetograms and 10830A spectroheliographs are routinely obtained and substantial observing time is dedicated for special-purpose programs of spacecraft support and basic research by Laboratory staff.

W84-70482 **188-38-52**
Marshall Space Flight Center, Huntsville, Ala.
GROUND-BASED OBSERVATIONS OF THE SUN
M. J. Hagyard 205-453-0118
(188-38-53)

The objective of this research is a program of ground-based observations for basic research concerning solar vector magnetic fields and for support of NASA solar missions using the facilities of the MSFC Solar Observatory. In the program of basic research, theoretical and observational programs are undertaken to study vector magnetic field structures which are relevant to current problems in solar physics. To support future NASA solar programs, techniques of observation and of data reduction and analysis are developed using the MSFC vector magnetograph. Such techniques will generate guidelines for operations of planned space-based magnetographs, and will provide more focused direction for the research performed with these instruments. Support of ongoing NASA solar missions is provided through daily observations, transmission of magnetograms to P.I.'s and other relevant personnel, and coordinated observing programs associated with collaborative investigations with mission P.I.'s.

W84-70483 **188-38-53**
Marshall Space Flight Center, Huntsville, Ala.
LABORATORY AND THEORY
R. L. Moore 205-453-0118
(188-38-52)

The general objective is to determine basic empirical properties of solar magnetic fields and their effects in the solar atmosphere. The general approach is to analyze MSFC vector magnetograms along with complentary data from other observatories and from SMM, and to interpret observed effects with physical models. More specifically, we will pursue the following studies: (1) electric current and magnetic energy in active regions; (a) the surface distribution of the vertical current and its relation to magnetic structure in the photosphere and chromosphere and to emission features in the chromosphere and transition region, (b) resistive heating of the transition region, and (c) estimates of the total magnetic energy and net Lorentz force; (2) magnetic structure and evolution of active regions: (a) how magnetic flux disappears from the surface of the Sun, (b) the field configurations in which flares occur and how these configurations form, (c) short-term magnetic evolution triggering flares, and (d) magnetic structure and dynamic phenomena in sunspots; (3) magnetic transients in flares: (a) synchronism with impulsive energy release, and (b) relation of photospheric magnetic changes to magnetic transient in chromosphere and corona in filament-eruption flares; (4) solar cycle studies: (a) further analysis of the poleward meridional flow and polar field injections, (b) inference of the operation of the solar cycle, and (c) statistical properties of active regions; (5) fine-scale magnetic structure and activity: (a) modeling of inhibition of heat conduction into transition region by magnetic constriction, (b) heating of the transition region by fine-scale electric currents, and (c) ephemeral active regions and spicules, and their relation to coronal heating.

W84-70484 **188-38-53**
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENT DEVELOPMENT - LABORATORY AND THEORETICAL SOLAR PHYSICS
Robert D. Chapman 301-344-6184

The primary objective is to support the laboratory's on-going programs by developing fundamental techniques for the interpretation of solar data. Specific goals include: (1) correctly interpreting the nature of observable solar phenomena by understanding fundamental spectroscopic processes; and (2) understanding the flow of mass, energy and momentum from a mechanical energy reservoir such as the convection zone to the chromosphere and corona. We will focus upon: (1) the conversion of mechanical energy associated with the photospheric velocity fields into a nonthermal energy flux; (2) the propagation of this nonthermal energy from its point of generation within the photosphere to the chromosphere and corona; (3) the irreversible conversion of this energy into thermodynamic end products within the chromosphere

and corona; (4) the nuclear processes occurring in solar flares, observed in the gamma ray spectrum; (5) consolidation of the above processes into models that predict new solar phenomena and explain those already observed.

W84-70485 **188-41-24**
Goddard Space Flight Center, Greenbelt, Md.
ULTRAVIOLET DETECTOR DEVELOPMENT
D. Weistrop 301-344-5781

The objective of this RTOP is the development of a photon-counting detector suitable for future space astronomy missions. The detector will be sensitive to far ultraviolet wavelengths, has a large format and high resolution. The design is exceedingly flexible, so that once the concept has been proved, future detectors can be optimized for particular missions. The detector to be built consists of an image converter/intensifier module fiber optically coupled to a mosaic of Charge Coupled Devices (CCD's) which provide a digital readout. The photocathode is deposited on the input side of a large Microchannel Plate (MCP) intensifier. The output from the MCP is proximity focussed onto a phosphor screen which is intagliated into the cores of a fiber-optic coupler. The coupler module consists of a 3 x 3 array of fiber optic tapers, each of which is coupled to a single CCD. The CCD's are read out in parallel. A prototype consisting of a small MCP coupled with a single fiber-optic taper and CCD will be fabricated and tested. The experience gained in the prototype design and fabrication will be fed back into the development program.

W84-70486 **188-41-51**
Goddard Space Flight Center, Greenbelt, Md.
UV AND OPTICAL ASTRONOMY
Jan M. Hollis 301-344-7591

The objective is to pursue a long range program in astronomical research with emphasis on detector and instrumentation development, theoretical astrophysics relevant to the interpretation of space observations, and other specific topics of special interest to NASA. The effort includes operation of ground telescopes, evaluation of new instrumentation for potential space application, and development and evaluation of detector systems that are candidates for space flight. In the course of evaluating detectors and instruments, spectroscopic and photometric data are obtained from ground telescopes concerning the properties of stellar atmospheres, nebulae, the interstellar medium, and galaxies. Theoretical investigations are carried out regarding the formation and evolution of galaxies and on the evolution of stellar interiors, variable stars, novae, and planetary nebulae.

W84-70487 **188-41-53**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF GALAXIES, ACTIVE GALACTIC NUCLEI THE INTERSTELLAR MEDIUM, MOLECULAR CLOUDS, AND STAR FORMATION
D. C. Black 415-965-5495

The objective of this RTOP is to conduct theoretical studies on fundamental phenomena associated with continuum spectra, dynamics, and line spectra in active galactic nuclei; the formation and evolution of galaxies and clusters; random luminosity fluctuations in compact astrophysical objects; molecular cloud formation and evolution; star formation; and infrared emission in interstellar shocks. A large fraction of this effort involves computational astrophysics employing a wide variety of numerical codes developed at Ames to treat multidimensional particle problems, and complex radiative transfer problems.

W84-70488 **188-41-55**
Goddard Space Flight Center, Greenbelt, Md.
INFRARED AND SUB-MILLIMETER ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-54; 385-41-01; 154-50-80; 157-05-50)

The scientific objective of this program is to provide better understanding of the current state and evolution of astronomical objects. This is achieved by observations at wavelengths from 1 micrometer to 1 mm and at spectral resolution (lambda/delta lambda) from 1 to 10 to the 7th power. Since atmospheric opacity and emissivity prohibit or severely limit ground-based observations at certain wavelengths (e.g., 4 micrometers to 8 micrometers and 13 micrometers to 700 micrometers), high altitude observational platforms such as the C-141, balloons, or satellites must be used. High sensitivity composite bolometers are being developed in the far infrared to take maximal advantage of low background conditions achievable at these altitudes. A balloon-borne 1.2m telescope is used to conduct a photometric survey of galactic souces of submillimeter radiation, and at least a partial survey of extragalactic sources at these wavelengths. An infrared sky camera is also used to quickly map various sources. Infrared and submillimeter coherent (heterodyne) spectrometers are developed and used to measure completely resolved intensity profiles for neutral and ionized molecular and atomic lines. Correlative studies are made when possible to enable maximum insight into the physics of the medium.

W84-70489 **188-41-57**
Jet Propulsion Laboratory, Pasadena, Calif.
UV AND OPTICAL ASTRONOMY
W. T. Huntress, Jr. 213-354-8275

Laboratory work will be performed to measure products and rate constants or ion-molecular reactions leading to the synthesis of interstellar molecules. This work provides data to help interpret the abundance of observed interstellar molecules, and to predict new species. The data are used in models of interstellar clouds in order to describe molecular evolution in astrophysical environments. Microwave spectroscopy measurements will be made of atomic and molecular species to support airborne (KAO) and Earth orbital observing actities. Laboratory measurements will be made to provide electron impact excitation cross sections and UV photoionization cross sections of cosmically abundant atoms and molecules for stellar modeling. Experimental electron/photon cross section data are needed in the detailed balance equation to model the non LTE conditions of stellar atmospheres, HII regions and interstellar clouds. Inelastic electron scattering cross sections will be measured for the ions MgII, CII and SiII. Transitions in these ions are important in determining chromospheric models, and are measured in IUE spectra of cool stars and supernova remnants. measurements will be made for both resonance and intercombination transitions and, where appropriate, comparison made to the Gaunt-factor predictor approximation for obtaining collision strengths. Laboratory measurements will be made to determine electron impact excitation cross sections and oscillator strengths of importance in modeling emission and absorption features originating from stellar, quasar and interstellar sources in the UV and EUV spectral region. These measurements will be used: (1) in analyzing emission line intensities and equivalent widths of absorption lines in order to derive information concerning the atmospheric layers (temperature and density) producing the line; and (2) in analyzing relative line intensities to determine stellar abundances and temperatures.

W84-70490 **188-46-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ASTROPHYSICS AND EXPERIMENT DEFINITION STUDIES
J. F. Ormes 301-344-8801

The objective is to study the properties of the cosmic radiation in order to understand its origin and propagation, and to study the properties of the sites in which element synthesis and acceleration take place. The particles observed are the nuclear and electronic species of the cosmic ray particles: their energy spectra, their charge and isotopic composition, and their distribution in space. Some of these objectives can be met through the imaginative use of short duration observations on balloons and utilizing week-long observations on Spacelab. Many heavier, larger-area payloads will require a space platform. Experiments which must be outside the magnetosphere can be done on explorer class spacecraft. Supporting these objectives is both the development of new detector systems for studying the properties of solar and galactic cosmic rays and the associated development of

theoretical studies relating to the sites, origin, models for acceleration, mechanisms for particles transport, etc., related to these experiments. The emphasis will be on studying the solar charge composition in the iron to uranium region, on precise measurements of isotopic abundances of solar and galactic cosmic rays, and to accurately determine the charge composition of galactic cosmic rays at the highest possible energies.

W84-70491 **188-46-57**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY ASTRONOMY
C. E. Fichtel 301-344-6281

The technical objective is to develop the most appropriate detector system for the observation of the astrophysical sources of very energetic photons. The first approach was the development of a large high energy telescope using digitized spark chambers. Many major improvements to this basic telescope system are still being pursued and other approaches to detector systems are now being developed for the high energy, intermediate energy, and low energy gamma ray observations. In the high energy region, improvements in the track imaging chamber systems are continuing, and special attention in the track imaging chamber research is now being directed towards drift chambers and larger spark chambers. At the same time, several approaches are being explored to improve angular resolution, including techniques to concentrate on higher energy photons. Improved attitude and aspect systems are being built. In the medium energy interval (8 to 50 MeV), a second generation experiment has now been flown on a balloon. In the 1/2 to 40 MeV region different detection processes become dominant and hence, new detector techniques are required. A totally new detector is currently being built based on the Compton interaction process, but including several new concepts which together should increase the sensitivity by a factor of ten. For gamma-ray burst studies new detector systems are being developed both for the gamma-ray energy range and for detection at other wavelengths. In particular, a ground-based system is being developed to detect and precisely locate optical flashes that are likely to occur in coincidence with gamma-ray bursts.

W84-70492 **188-46-57**
Jet Propulsion Laboratory, Pasadena, Calif.
GAMMA-RAY ASTRONOMY
A. S. Jacobson 213-354-6263

This describes the JPL program in X- and gamma-ray astronomy. The primary objective of the program is the development of advanced instrumentation to be applied to gamma-ray observations in the energy range of .02 to 10 MeV, with emphasis on position sensitive sensors for use in high resolution imaging spectrometers. The major effort being brought to completion is the development of large-volume position sensitive germanium detectors. Fiscal year '84 will also see the initiation of investigations into the application of liquid time projection chambers.

W84-70493 **188-46-58**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY SPECTROSCOPY
B. J. Teegarden 301-344-5277

The objectives of this effort are the development of new instrumentation to perform high resolution spectroscopy and imaging of celestial gamma-rays in the 0.01-10 MeV range, and the flight of this instrumentation on high altitude balloons to assess the performance in a space-like environment and to gather scientifically meaningful data. In particular, the instrumentation will be designed to search for and measure the properties of narrow lines in the celestial gamma-ray spectrum. A major goal of this work will be the demonstration of new ideas and techniques for the eventual use in a satellite-borne experiment. The approach will center on the use of high purity Germanium detectors to perform the most precise possible measurements of the gamma-ray energy. In addition, new techniques will be explored to further suppress instrumental background and thereby improve the sensitivity of the experiment. Finally new methods will be explored for constructing images of the gamma-ray sky with an accompanying improvement in angular resolution over earlier experiments.

W84-70494 **188-46-59**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY ASTRONOMY
E. A. Boldt 310-344-5853

Celestial X-ray sources have introduced us to rich new aspects of astronomy ranging from the millisecond bursts of hard X-rays coming from the innermost orbits of matter falling into a black-hole to the diffuse emission from extensive hot plasmas associated with clusters of galaxies. The combination of large sensitive area, low detector background, high temporal resolution and non-dispersive spectroscopy over a broad band-width has been our approach in discovering and exploring these phenomena. The power of this approach has been well demonstrated. Extending it with improved spectral resolution and broad-band imaging is a major area of development now indicated. This involves the creation and evaluation of new systems incorporating low noise detectors of optimum energy resolution, large area X-ray concentrators and imaging devices.

W84-70495 **188-46-59**
Jet Propulsion Laboratory, Pasadena, Calif.
X-RAY ASTRONOMY CCD INSTRUMENTATION DEVELOPMENT
A. S. Jacobson 213-354-6263

Recent tests have demonstrated that three-phase and virtual-phase Charge-Coupled Devices (CCDs) have high spatial resolution, moderate spectral resolution, and high detection efficiency for single X-ray photons. This program is a joint effort with Pennsylvania State University (PSU). The objective of this RTOP is to develop a CCD-based imaging X-ray spectrometer for X-ray astronomy observations, and to use this instrumentation to study the temperature and abundance distributions as well as the state of ionization of cosmic X-ray sources. The approach for this program consists of two development efforts: (1) using a CCD detector of the type which is available now, a spectrometer will be developed, tested, calibrated, and used at the focal plane of a rocket-borne grazing-incidence telescope; (2) a parallel detector development program will optimize CCD properties which are required for operation at the focus of advanced grazing incidence X-ray telescopes.

W84-70496 **188-78-38**
Jet Propulsion Laboratory, Pasadena, Calif.
STARPROBE - ADVANCED TECHNOLOGY MANAGEMENT AND PLANNING
J. E. Randolph 213-354-2732

This RTOP will support the STARPROBE advanced technology management and development which will culminate in a series of thermal shield materials development tests at the solar furnace at Odeillo, France in the spring of 1984. This is part of a multi-center and international program supported, also, by NASA-OAST, CNES, and CNRS (French agencies). The tests will be the first time that refractory shield materials will be tested in a high solar flux in a space vacuum. The thermal properties and mass loss data acquired during the test will provide a new data base of the properties of refractory materials in a high-flux vacuum environment. The detailed objectives include: (1) management and coordination of the test program; (2) liaison between JPL, NASA-ARC (and their contractor, SAI) and CNES; (3) supporting the ARC contractor in developing test samples, fixtures, and test data planning and analysis; (4) provide special mass-loss instrumentation for the tests; (5) support long term STARPROBE mission planning; (6) provides support manpower for the materials tests; and (7) support a update of the shield design concept utilizing the tests results.

W84-70497 **188-78-51**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED TECHNOLOGICAL DEVELOPMENT, GENERAL: SIGNAL AND DATA PROCESSING ELECTRONICS: SOLID STATE DETECTORS
D. E. Stilwell 301-344-6454

The objectives of this research project are to develop and test new on-board signal handling, processing, storage, computing and auxiliary circuitry for use in energetic particle and astrophysics experiments on spacecraft, rockets, balloons, etc., as well as special test and analysis equipment applicable for both ground and shuttle usage. The growing complexity of experiments and the corresponding increase in the volume of data obtained have made signal handling, data processing and data transmission capability limiting factors. The aim is to reduce the transmission of unnecessary data, and support the requirements of ever-more complex instruments necessary to increase the experiment's on-board signal handling and data processing capability. This program is approached through the investigation and development of techniques for signal shaping and handling, data processing and auxiliary circuitry, and through the modification of existing techniques by the application of advanced technology and materials, including MOS/LSI and semi-custom technology, thick film techniques, multiple chip techniques, and microprocessors. The technical objective of the research project is to conduct a program of research and development, and device test and evaluation of silicon and germanium nuclear radiation detectors with emphasis on the improvement of detector technology; and the understanding of radiation and chemical damage effects on device operation and lifetime. Technology will be established for the fabrication of specialized devices not available from industry and pragmatic life testing will continue.

Planetary Astronomy

W84-70498 **196-41-50**
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED INFRARED ASTRONOMY
D. E. Jennings 301-344-7701
(188-41-55; 154-50-80)

The scientific objective is to determine information on astrophysical objects, such as molecular and circumstelllar components in stellar atmospheres; and planetary atmospheres from high spectral resolution ground-based measurements in the intermediate infrared. A spectrometer system employing a cryogenic Michelson interferometer (77 K) has been developed to meet the simultaneous requirements of high spectral resolution, a wide free spectral range and high sensitivity. An optical retardation up to 25 cm will provide an unapodized spectral resolution up to .02/cm in the 400 to 2000/cm range. A post-dispersed detection system is being fabricated to reduce background noise from a warm telescope system and the atmosphere at the detector; thus allowing the multiplex advantage of the interferometer to be retained. The cooled instrumentation with the post-dispersed detection system, operating at a favorable infrared site, will allow maximum sensitivity to be attained for an interferometer system at a ground-based site. The sensitivity level for a measurement in the 100/cm (10 micrometer) region with a 122 cm diameter telescope, an integration time of 60 minutes and a spectral resolution of 0.2/cm is approximately 5 x 10 to the -26th power watts /sq m/hz. The S/N level for Jupiter in the 1000/cm regions with the above system is approximately for one minute integration time and full spectral resolution of 0.02/cm. Initial observations are planned for FY-84 with the low spectral resolution post-dispersion system with the FTS instruments at Mt. Lemmon and KPNO.

W84-70499 **196-41-52**
Goddard Space Flight Center, Greenbelt, Md.
IMAGING STUDIES OF COMETS
John C. Brandt 301-344-8701

This RTOP provides for the operation of a small high altitude observatory, Joint Observatory for Cometary Research (JOCR), for imaging research on comets and their interactions with solar radiation and the solar wind. This research is carried out with ground-based images alone or if suitable data from spacecraft such as Solar Polar Mission or Halley deep-space probes are available, with an appropriate combination of ground-based and in-situ measurements. It should be noted that funding under this RTOP provides support for the operation of the observatory only; analysis of research results is funded by the interested Program Office. In addition, when suitable bright comets appear radio observations will be made at existing national facilities, and other visible wavelength observations will be carried out at other suitable facilities.

W84-70500 **196-41-54**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED INFRARED ASTRONOMY AND LABORATORY ASTROPHYSICS
Michael J. Mumma 301-344-6994
(188-41-55; 154-50-80; 157-05-50)

The objective of the advanced infrared astronomy program is to study the molecular constituents of solar system objects (e.g., planetary atmospheres and comets) through observations of their IR line spectra, and so to further knowledge about: (1) molecular abundances; (2) kinetic, vibrational, and rotational temperature distributions; (3) kinetic velocity shifts (winds); (4) vertical and horizontal abundance distributions; and (5) ambient gas densities, and to carry out comparative studies of these objects. The physical information sought is contained in the intensity profiles of isolated spectral lines and can be obtained by inversion of the observed line shapes. The measurement of spectral line shapes is now a tractable problem at IR wavelengths, and line shapes can be measured by infrared heterodyne spectroscopy. The approach is to develop and employ coherent detection line receivers for use in the infrared wavelength regions. The instruments use either gas lasers or semi-conductor diode lasers as local oscillators, and HgCdTe detectors as photo-mixers. The intermediate frequency signal is fed into a GSFC standard spectral line receiver which acquires, analyzes, and displays the spectral lines. Initial observations with this system have been from the ground, but it has been developed with an eye toward flights on the NASA C-141 and in space. Laboratory work on precise line frequency determinations and on pressure broadening effects is also carried out in support of the field experiments.

W84-70501 **196-41-67**
Ames Research Center, Moffett Field, Calif.
PLANETARY ASTRONOMY AND SUPPORTING LABORATORY RESEARCH
F. P. J. Valero 415-965-5510

The composition of planetary atmospheres and surfaces and the abundance, temperature and pressure of certain atmospheric constituents can be determined by spectroscopic observations from ground-based and and from airborne observatories. Such data are necessary for the preparation of valid model atmospheres, which are needed to evaluate the possibilities of life on the planets and to design systems for exploratory missions and for the preparation of evolutionary models of planetary interiors. The objectives of this work are to obtain, study and analyze spectroscopic observations of the planets and their satellites; to obtain and analyze, in the laboratory, spectra appropriate for valid interpretation of planetary observtions; and to develop the analytical and computational techniques necessary to interpret planetary spectra in terms of real planetary atmospheres and surfaces. The objectives will be pursued by measuring, in the laboratory, basic molecular parameters such as absorption line and band intensities, band modeling parameters, absorption line half-widths, vibration-rotation interaction constants, and line pressure induced shifts and absorption. The dependence of these parameters on pressure and temperature will be obtained by using long path gas cells, cooled gas cells, and high resolution spectrometers and interferometers operating primarily in the infrared. Spectra of the planets and their satellites will be obtained by using airborne and ground-based

telescopes and will be analyzed to obtain information about the composition and structure of their atmosphere and the composition of the surface.

W84-70502 **196-41-68**
Ames Research Center, Moffett Field, Calif.
DETECTION OF OTHER PLANETARY SYSTEMS
D. C. Black 415-965-5495

The long-range objective of this activity is to develop a comprehensive program to detect other planetary systems. The near-term objectives include the funding of selected University researchers to pursue modest exploratory developmental and observtional programs as well as theoretical studies directed at identifying optimum techniques for ground-based planetary detection systems. The choice of University researchers will be based on a peer review of unsolicited proposals, and it will be guided by the basic recommendations set foth in Volume I of NASA CP-2124. Funding will also be used to support in-house theoretical research at Ames Research Center related to the detection and study of other planetary systems.

W84-70503 **196-41-71**
Jet Propulsion Laboratory, Pasadena, Calif.
OPTICAL ASTRONOMY
R. J. Terrile 213-354-6158

The overall objective of the Ground-Based Optical Astronomy task is physical study of planets and their satellites, by means of ground-based observations, at visible and near-infrared wavelengths (approximately 0.3 to 2.0 microns). This task consists of several subtasks: (1) planetary spectroscopy, to investigate the physical and chemical properties of the upper tropospheres of Venus, Jupiter, Saturn, Uranus, and Neptune through high resolution astronomical spectroscopy and spectrophotometry; (2) Io spectroscopy & sodium D-line imaging, to investigate the physical state and bulk motions of the neutral sodium cloud associated with Io, through a variety of advanced high resolution spectroscopic techniques, and to investigate the temporal and spatial behavior of the Na D-line emission from the Jovian satellite Io (J-1) through a synoptic program of spectroscopic and imaging observations; (3) Fabry-Perot spectroscopy, to make comprehensive observations through Fabry-Perot spectroscopy and CCD images of the visible and near infrared emissions from trapped ions in the Jovian magnetosphere, leading to a detailed description of the evolution and physical characteristics of the Jupiter/Io (SII) - (SIII) nebula. In addition to these primary subtasks, the Ground-Based Optical Astronomy task provides limited operational support (equipment maintenance and setup, observing assistance) at Table Mountain Observatory (TMO) to programs supported from other sources. The principal program supported in this manner is the asteroid dynamics task under the supervision of A. Harris (JPL).

W84-70504 **196-41-75**
Jet Propulsion Laboratory, Pasadena, Calif.
COMETS
R. L. Newburn, Jr. 213-354-2319

This RTOP covers three individual tasks: (1) physical processes in comets; (2) cometary dynamics; and (3) IR photometry of short-period comets. Once the perihelion of any cometary orbit lies among the planets, brought there perhaps by stellar perturbations, the orbit begins to evolve rapidly compared to the age of the solar system. Once the perihelion reaches 3 to 5 AU, the comet begins to change physically with great rapidity, typically becoming an inert, degassed body after 1000 revolutions. Physical activity changes the orbit, and orbital changes alter the physical activity. The current objectives of this RTOP are to investigate the dynamics and orbital evolution of a number of periodic comets and their end products, the attendant meteor streams, and to maintain a continuing program of ground-based physical observations of comets and the interpretation of these observations, giving emphasis to a quantitative understanding of the physical processes which give rise to the phenomena of nucleus, wavelengths in order to enhance the value of data taken on those few that become targets for space missions. Ground-based observations will be carried out at Mauna Kea, Lick, and other observatories using the best auxiliary equipment available at each. An investigation will be continued of the dynamics and orbital evolution of several periodic comets and their attendant meteor streams. The obvious nongravitational forces affecting the motions of comets will be modeled by assuming these forces are due to the rocket effect of outgassing cometary ices. Once the astrometric cometary observations for each comet have been used to refine the existing nongravitational force model, the cometary nucleus spin direction, spin axis evolution and nuclear ice volatility can be inferred. For those comets with associated meteor showers, the meteor shower data will be used to characterize the dust distribution in the neighborhood of the parent comet.

W84-70505 **196-41-76**
Jet Propulsion Laboratory, Pasadena, Calif.
ASTEROIDS
D. L. Matson 213-354-2984

This RTOP contains four tasks to further the understanding of asteroids, their origin, compositions, relations to other planets, satellites and comets, and whether or not they pose a hazard to mankind through impacts on the Earth. The Origin of Asteroids and Small Bodies task supports telescope observations and the determination of orbits and ephemerides for faint asteroids and newly discovered objects and, thus, is a service to the entire asteroid research community. In the Physical Properties of Asteroids Task the spectral reflectances of asteroids are measured. This allows the classification of asteroids by parameters which are related to composition and size. In the coming year photometry at wavelengths of 0.56, 1.2, 1.6 and 2.2 microns will be carried out for selected asteroids. Objects of special opportunity or interest will be studied by CVF spectrophotometry and photometry at 3.5, 4.8, 10 and 21 microns. The Systematic Search for Earth-Crossing Asteroids Task is a search program designed to discover new members of the Apollo, Amor and Aten asteroid groups. All of these objects must be discovered on their close approaches to the Earth. They are so small that at other times they are not locatable even with large telescopes. This effort is currently using telescopes in the United States and Australia. The purpose of the Asteroid Team task is to support the operation of the asteroid research team at JPL. In addition to carrying out original research on asteroids, this team provides scientific and technical advice to other elements of JPL and NASA in order to assist them carrying out asteroid related missions.

W84-70506 **196-41-77**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY INFRARED IMAGING
R. J. Terrile 213-354-6158

The objective of this program is to provide high spatial resolution, ground-based infrared and visible images and spectra of the Jupiter, Saturn, Uranus and Neptune systems. These data directly support instrumentation on the Voyager mission to Jupiter, Saturn, Uranus and Neptune and the proposed Galileo mission to Jupiter. Jupiter will be observed in the 5 micron window into the deep atmosphere as a continuation of a very successful program to monitor Jovian weather patterns throughout the Voyager post-encounter period. Saturn will be observed at various infrared wavelengths in order to determine if atmospheric features seen from the ground can be correlated with those observed by Voyager instruments. Ground-based observations will be combined with Voyager Imaging Science and Infrared Interferometer Spectrometer (IRIS) data. Imaging data collected with a CCD coronagraph at 8900 A and scan data in the infrared at 2.2 microns will allow detailed observations of Saturn's E-Ring and provide ground-based information on Jupiter's newly discovered ring and satellite 1979 JI. This came CCD system will be used to observe the newly discovered satellites of Saturn and to conduct satellite searches around Uranus and Neptune. Several comets will also be studied in the visible and infrared including a search for comet Halley and observations designed to determine the albedo and size of the nucleous. Observations will be made with an existing infrared imaging system at the Hale 5-meter telescope at 1 to 5, 8 to 14

and 20 microns and scans will be acquired at the 3-meter NASA-IRTF at Mauna Kea Observatory. The CCD images will be acquired from the Palomar 5-meter and 1.5-meter telescopes using an existing camera and data analysis facility at Galtech. Uranus and Neptune satellite searches will be conducted from the du Pont 2.5 meter telescope at Las Campanas Observatory in Chile.

Life Sciences SR&T

W84-70507 **199-10-11**
Lyndon B. Johnson Space Center, Houston, Tex.
OPERATIONAL LABORATORY SUPPORT
W. H. Shumate 713-483-4461

The objective of the Operational Laboratories Support RTOP is to provide medical operations support by the Johnson Space Center (JSC) to approved Agency programs. The medical operations support provided under this RTOP includes the conduct of studies to investigate countermeasures to physiological changes which occur when man is exposed to the spaceflight environment; clinical laboratory support of astronaut health programs; preflight and postflight testing of astronauts; and, operational tests and studies of the spacecraft environment, life support equipment, habitability systems, medical procedures and support equipment. The approach utilized to accomplish this objective is to maintain discipline oriented laboratories in each of the physiological problem areas covered by the Life Sciences SR&T RTOP program. This RTOP provides the funds for laboratory staff, equipment, supplies and data management support to accomplish the operational medicine goals and objectives of the Agency.

W84-70508 **199-10-12**
Ames Research Center, Moffett Field, Calif.
OPERATIONAL MEDICINE LABORATORY
D. Goldwater 415-965-5749
(199-10-11)

This RTOP supports the operation and maintenance of the facilities necessary to conduct basic medical research to assure the health and well-being of astronauts. These facilities are used to investigate the effects of physiological changes that occur when humans are exposed to spaceflight stresses. Additionally, the facilities are used to devise techniques to counteract any deleterious physiological deconditioning due to spaceflight. The Operational Medicine Laboratory gives NASA the capability to conduct in-house human medical research necessary to maintain health and well-being during and after spaceflight. Support for medical operations includes pre- and postflight tests of astronauts to provide comparative data from spaceflight for controlled studies on Earth.

W84-70509 **199-10-21**
Lyndon B. Johnson Space Center, Houston, Tex.
MEDICAL OPERATIONS LONGITUDINAL STUDIES
Edward C. Moseley 713-483-4461

The objective of the research covered by this RTOP is to conduct longitudinal retrospective and prospective studies of the medical data on the U.S. astronauts, some of whom have flown in space, and a control group of JSC civil servants matched on the basis of age, sex, body size and smoking history. The studies covered involve individuals in a closed population in an attempt to relate changes in physiology and/or pathology to specific factors associated with individual traits of the astronauts and occupational exposure. Areas of study and of particular interest consist of acute responses and long term adaptive mechanisms to weightlessness; changes observed in complete annual physical examinations, changes in body fluids and cardiovascular systems, cellular changes in respiration; chromosomal aberrations, and, finally, the effects, if any, of the occupational exposures to health outcome, including physiological alterations, aging; and disease/disorder incidence.

W84-70510 **199-10-22**
Ames Research Center, Moffett Field, Calif.
LONGITUDINAL STUDIES
D. Goldwater 415-965-5749
(199-10-21)

This RTOP is designed to provide longitudinal retrospective and prospective studies of the medical data from astronauts and control populations, who are representative of shuttle crew and passengers. The objective of these studies is to broaden the population base of individuals eligible to fly by determining the effects of age, gender and other factors on an individual's ability to withstand the rigors of actual and simulated spaceflight. Areas of particular interest consist of acute responses to weightlessness, adaptation to weightlessness, physiological deconditioning, and recovery from the effects of spaceflight, as they are affected by factors such as aging or disease. The basic approach involves developing of and testing hypotheses using weightlessness simulation studies. Investigators analyze mechanisms of deconditioning and effectiveness of countermeasures (e.g., anti-G suit, exercise, drugs), as well as standardize effective monitoring techniques (e.g., echocardiograms) of various physiological responses. Results from subjects in studies of simulated weightlessness and follow-up longitudinal studies establish a data base for comparison with results from astronauts participating in actual shuttle flights.

W84-70511 **199-10-31**
Lyndon B. Johnson Space Center, Houston, Tex.
CREW HEALTH MAINTENANCE
James S. Logan 713-483-4021

Maintenance of space crew health is a primary objective of the manned spaceflight program. This RTOP is designed to provide guidance, procedures and equipment to achieve this objective, both now and in the distant future. Furthermore, a strict modular approach will be followed, thereby assuring a timely growth pattern for hardware development and diminishing the tendency toward sudden obsolence of an entire system because of one subunit's inadequacy. The concept of health maintenance can be dissected in the following way: disease prevention, disease diagnosis, and disease treatment. The tasks contained within this RTOP are directed toward one or more of these concepts.

W84-70512 **199-10-32**
Ames Research Center, Moffett Field, Calif.
CREW HEALTH MAINTENANCE
D. Goldwater 415-965-5749
(199-10-31)

The overall objective of this RTOP is directed towards maintaining crew health for spaceflight. Because astronauts are fully working members of each shuttle mission, crew health should be optimal to maintain high physiological performance for mission success. Human research is used to determine causes and potential countermeasures for physiological deconditioning, such as orthostatic intolerance, musculoskeletal changes. Human subjects are exposed to bedrest and water immersion to simulate the deconditioning which occurs during spaceflight. Data from these subjects are compared to results from shuttle crewmembers. Hardware is developed in support of both research and flight projects. Methods to counteract deconditioning (e.g., exercise, medication, optimal recovery periods) are evaluated.

W84-70513 **199-10-41**
Lyndon B. Johnson Space Center, Houston, Tex.
SYSTEMS HABITABILITY VERIFICATION
James M. Waligora 713-483-5457

A large portion of biomedical research conducted as part of the Space Program has to do with the effect of space specific environments on man and other organisms. What may be less obvious as a potential problem is that the environment that man is exposed to in space is almost entirely a man-made environment. Many environmental factors that are relatively constant in the Earth's atmosphere, such as O2 and CO2 concentration and pressure, must be carefully controlled by environmental control

systems in the space vehicle. Acceptable control ranges and emergency ranges for environmental factors must be specified and it must be verified that the spacecraft can maintain the environment within these specifications. The specifications must provide for the safety and well-being of the crew and must also provide an environment stable enough to allow biomedical study of the space-unique environmental factors. In arriving at specifications for these environmental factors, considerations must be given to the difficulty involved in controlling a given environmental factor within a given control range and the implications in terms of cost, weight, and reliability. Defining these limits and verification that the limits are met in the spacecraft will require research in several specific areas.

W84-70514 **199-10-42**
Ames Research Center, Moffett Field, Calif.
HUMAN HABITABILITY VERIFICATION
G. C. Carle 415-965-5765
(199-10-41)

The objective is to develop and fly specialized gas chromatographs which will perform routine analyses of the gases and volatiles in the various environments that shuttle crew members are subjected to during a mission. The approach will be to conduct a cooperative research and development program with the staff of the JSC Medical Sciences Division which will result in efficient flight hardware for analysis of the progress and extent of astronaut denitrogenation prior to extravehicular activity and for the detailed qualitative and quantitative analysis of trace volatile cabin atmosphere constituents.

W84-70515 **199-10-52**
Ames Research Center, Moffett Field, Calif.
GENERAL OPERATIONAL MEDICINE
A. B. Chambers 415-965-5729

NASA is examining the capabilities/limitations of a manned space station. Of major concern is the medical and human safety problems associated with manning a permanent station. These problems are examined with the help of the astronauts who have to date experienced space flight, and who have special insights into medical and safety hazards/issues associated with future space stations. This information joined with other carefully screened data will be used to develop a risk analysis data base to be used by program planners and managers, and design engineers to develop tradeoffs of human productivity losses vs. space station design parameters.

W84-70516 **199-10-61**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE MOTION SICKNESS
J. L. Homick 713-483-5457

Manned space flight has demonstrated that space motion sickness can be unpredictable and variable among individuals. A significant observation is that in individuals who do experience this problem, symptoms can persist through the first several days of flight. Thus, on short duration shuttle flights, a major portion of mission time could be spent with some crewmembers who are not operating at a maximum efficiency. The augmented operational research program outlined by this RTOP is directed specifically toward resolving the problem of space motion sickness. This RTOP has four objectives. These are: (1) a better understanding of the causes of this syndrom in 0-g; (2) criteria for accurately identifying, prior to space flight, individuals suspectible to space sickness; (3) satisfactory methods for the prevention of symptoms; and (4) effective methods for the treatment of symptoms when they occur. The approach will be to conduct an interrelated series of operationally oriented ground based and space flight studies which are designed to address one or more of the above objectives. Human subjects will be used exclusively. New facilities, hardware, and measurement procedures will be developed as required.

W84-70517 **199-10-62**
Ames Research Center, Moffett Field, Calif.
SPACE ADAPTATION SYNDROME
W. E. Berry 415-965-5736

The proposed flight experiment will endeavor to reduce the symptomatology associated with the Zero-g sickness syndrome through preflight training. We will also attempt, through monitoring physiological responses of crewmenbers, to provide: (1) continuous feedback of autonomic activity levels to be used by crewmembers in applying learned control of symptoms; (2) an objective measure of the extent to which this treatment effectively counteracts symptomatology, and (3) direct information on the characteristics of an individual's manifested symptoms. The training method combines two self-regulatory techniques, autogenic therapy and biofeedback. The new method, called Autogenic Feedback Training (AFT) has been shown to enable subjects to volitionally suppress their own motion sickness symptoms under several provocative conditions in Earth-based tests. These techniques will be used on a minimum of 2 astronauts in 8 to 10 training sessions beginning 6 months prior to Spacelab 3. Control subjects (crewmembers) will be monitored but will not be given AFT.

W84-70518 **199-20-11**
Lyndon B. Johnson Space Center, Houston, Tex.
CARDIOVASCULAR DECONDITIONING (JSC)
M. W. Bungo 713-483-5457

The overall goal of this program is an understanding of the cardiovascular changes (termed Cardiovascular Deconditioning) which occur with space flight and their impact on crewmembers. Specific aims are to: (1) define the underlying mechanisms of cardiovascular deconditioning; (2) provide appropriate countermeasures for these effects; (3) develop systems to aid in the accomplishment of these goals; and (4) apply the results of the preceding in an operational sense for selection, retention, and health maintenance of future space travelers. Ground based studies on both human and animal subjects will in part utilize provocative techniques such as, exercise testing and lower body negative pressure; bedrest studies as an analogous condition to weightlessness; noninvasive and invasive cardiovascular monitoring; and pharmacologic interventions, all in an effort to accomplish the goals set forth above. Direct inflight applications or continued research will be the continuum. Impact will be greater access to the space environment for more diverse segments of the population under a greater variety of conditions.

W84-70519 **199-20-12**
Ames Research Center, Moffett Field, Calif.
CARDIOVASCULAR DECONDITIONING
H. Sandler 415-965-5745
(199-20-11; 199-20-13; 199-20-14)

The overall goal of this program is an understanding of the cardiovascular changes that regularly occur with spaceflight. Specific aims are to: (1) define the underlying mechanics of cardiovascular deconditioning; (2) determine whether specific cardiovascular risks occur with short and long term weightlessness exposure; (3) develop appropriate countermeasures for observed changes; and (4) develop and implement appropriate spaceflight experiments. To accomplish this goal, ground based studies on both human and animal subjects will be carried out. Specific activities will include: (1) immobilization (body casting) in animal models; (2) determination of the effects of exercise training; (3) the use of provocative orthostatic stress tests such as centrifugation, change in body position (tilt) and water immersion, and (4) tests of procedures, devices and drugs to prevent and counteract deconditioning. Results should lead to: a better understanding of the mechanisms of cardiovascular deconditioning; better devices and procedures for modifying deconditioning effects; specific spaceflight experiments as an understanding of the risks attendant with spaceflight. Impact will be greatly improved flight safety, access of a broader segment of the population to spaceflight, and use of the weightless environment to expand our understanding of cardiovascular function.

W84-70520 **199-20-14**
Jet Propulsion Laboratory, Pasadena, Calif.
CARDIOVASCULAR DECONDITIONING
R. H. Selzer 213-354-5754

The objective of this task is to develop minimally invasive methods for characterization of coronary and carotid anatomy in order to evaluate the anatomy of these two critical vascular beds in spaceflight personnel who develop symptoms during a mission or during the period of readjustment to gravity as well as evaluate the suitability of personnel who may have latent asymptomatic atherosclerosis to prolonged exposure to spaceflight environment. Coronary assessment will be obtained by image processing techniques applied to intravenous angiograms from an advanced new digital radiographic system. Ultrasound images from one commercial and one experimental scanner will be processed by computer methods to characterize carotid anatomy. The computer is used in both cases to synthesize high quality vascular images by extraction of information from large numbers of low quality noisy images. The angiographic analysis will include extension of computer algorithms developed for coronary film images to digital radiographic images and validation of the technique on human subjects. The ultrasound analysis will involve (1) development of algorithms to synthesize a high quality carotid volume image from multiple distributed cross-sectional images and (2) quantitative comparison of the synthesized image with a carotid angiogram. The method will also be tested on human subjects. It should be emphasized that this is an image processing study and does not include X-ray or ultrasound instrument development.

W84-70521 **199-20-22**
Ames Research Center, Moffett Field, Calif.
SENSORY-MOTOR REARRANGEMENT
N. G. Daunton 415-965-6245
(199-20-21)

Various sensory-motor problems related to the process of adaptation to the O G environment, such as, space motion sickness, perceptual illusions, motor performance deficits, attentional deficits, and loss of adaptation are encountered during and after short and/or long-term exposure to weightlessness. These problems, which arise from the rearrangement of sensory-motor interactions during exposure to O G, impair the health, safety, and operational efficiency of astronauts. The goal of this program is to identify the exact causes of such problems and to determine the basic neurophysiological mechanisms underlying them. Currently, the major emphasis is placed on determining the causes and neurophysiological mechanisms underlying space motion sickness. A broad-based program of interrelated psychophysical, neurophysiological, biochemical, and neuroanatomical studies are performed to determine the role of the vestibular, visual, somatosensory, motor, and other systems and their interactions in the development of space motion sickness and other sensory-motor problems. The symptomatology of motion and space sickness will be studied, and the effects of the adaptation process and of various pharmaceutical agents on this symptomatology will be determined. Studies will be undertaken to identify neurotransmitters and other biochemical factors involved in motion and space sickness. Hypotheses about the etiology of, and possible countermeasures for, space sickness will be developd from ground-based research. Flight experiments will be used to test hypothesis and validate suggested countermeasures.

W84-70522 **199-20-31**
Lyndon B. Johnson Space Center, Houston, Tex.
BONE LOSS
N. M. Cintron-Trevino 713-483-4086

The regulation of bone integrity and function during space flight and the causes of its apparent demineralization are the central questions addressed by the present research program. It intends as its overall research goals to elucidate and define the mechanisms operative in the processes associated with calcium metabolism and bone loss during weightlessness, to develop methods to assess changes more accurately by non-invasive means, and to develop effective countermeasures to these deleterious skeletal changes in order to optimize man's performance and recovery upon return to a one-g environment. Using ground-based model systems, human clinical and animal basic research to define the molecular mechanisms underlying bone mass regulation and loss, will focus on the biochemical, endocrinological, and physico-mechanical levels of functions. Preventive and remedial countermeasures will center primarily around mineral supplementation, drug administration, diet modification, and physical manipulation.

W84-70523 **199-20-32**
Ames Research Center, Moffett Field, Calif.
BONE ALTERATIONS
D. R. Young 415-965-5549
(199-20-31; 199-20-34; 199-40-32)

The overall objectives of this RTOP are to assess the operational impact of skeletal losses on crewmembers in future long-duration missions, to develop remedial countermeasures for the prevention of skeletal losses, and to develop medical selection criteria for re-exposures of astronauts to weightless environments. The program is implemented through ground-based studies with hypodynamic-hypogravic models. Immobilization studies with human volunteers and experimental animals are performed: (1) to document bone alterations and the recovery processes; (2) to determine degree of involvement and mechanisms of action of calcemic hormones in immobilization-associated osteoporosis; (3) to investigate the role of intestinal absorption as a causative fctor in bone loss, (4) to evaluate potential risk factors associated with skeletal losses; and (5) to evaluation potential protective countermeasures. Research is conducted at ARC, JSC, JPL, and through various grants and contracts.

W84-70524 **199-20-34**
Jet Propulsion Laboratory, Pasadena, Calif.
BONE LOSS (TOMOGRAPHIC IMAGING)
S. L. Manatt 213-354-4256

This program seeks to establish the extent and mechanism(s) of bone mineral changes due to zero-g and immobilization and the approaches for in vivo bone mineral measurements that best satisfy NASA's needs. This task consists of three continuing components and a new component (subject to AIBS review and available funding). The first is a research contract with the Medical School, University of California, at San Francisco (UCSF) for development of a gamma-ray CT system for bone mineral measurements and the testing of the latter instrument. From the performance of a prototype system with one Gd-153 source and a limited detector array, a proposal for the second stage of development of the full system is being formulated for AIBS review. The second component involves studies with a small gamma-ray scanner at JPL with the capability for investigations, both in the CT and absorptiometry modes of operation, of phantoms and standard samples. These latter will be used in the tests of accuracy and precison of the instrument assembled in the second stage of the UCSF gamma-ray CT system development. Part of the JPL effort will be directed towards consideration of the feasibility of applying the new nuclear magnetic resonance imaging techniques for increasing the understanding of certain biochemical details related to in vivo bone changes. A third component, also at UCSF, involves a research contract for clinical CT bone mineral measurements by current X-ray instruments, including a collaborative US-USSR study of bone loss in cosmonauts. The final new start portion of this task (subject to AIBS review) is work proposed from the University of Southern California (USC) Medical School for biochemical studies of the effects of various stresses on one turnover in model animal systems.

W84-70525 **199-20-42**
Ames Research Center, Moffett Field, Calif.
MUSCLE ATROPHY
S. Ellis 415-965-5757
(199-40-32)

The overall aims of this research program are to determine the underlying causes for the muscle atrophy problem observed in both humans and animals in space and to develop suitable

measures to counter these undesirable changes. Specific objectives consist of conducting basic studies into the nature of the biochemical and physiological mechanisms which regulate skeletal muscle mass and properties; and developing and validating methods for monitoring the rate of atrophy of skeletal muscle in human subjects and laboratory animals. Possible countermeasures which may forestall muscle atrophy induced by disuse and weightlessness will be investigated. Muscle atrophy will be induced by immobilization with casts; suspension hypokinesia; nerve paralysis; tenotomy; hormonal manipulation (endocrine organ ablation and hormone replacement); and reversal of hypertrophy by load and/or stretch removal. The possible mechanism underlying atrophy will be studied with regard to (1) muscle protein synthesis, degradation and regulation by growth factors, steroid hormones, stretch, prostaglandins, and receptor numbers; (2) definition of the specific proteolytic enzymes and pathways involved in muscle protein breakdown; and (3) evaluation of possible countermeasures such as exercise, protease inhibitors and other pharmacological agents.

W84-70526 **199-20-51**
Lyndon B. Johnson Space Center, Houston, Tex.
BLOOD ALTERATIONS
Gerald R. Taylor 713-483-4086
(199-20-60)

The most significant effects of the space flight environment on the blood and blood-forming tissues in man have been a postflight reduction in the blastogenic transformability of lymphocytes, a marked lymphocytopenia, granulocytosis, and a consistent reduction in the circulating erythrocyte mass. The variations in the magnitude of the loss in individual crewmen and the complicated postflight recovery kinetics suggests a complex relationship between the red cell mass loss and the duration of the exposure to space flight conditions. This 'anemia of space flight' was frequently accompanied by a reduction in plasma volume, apparently occurring early in the mission and sustained throughout the flight. Other, more subtle, effects have been observed with respect to the function and structure of red blood cells, and in the concentration of some plasma proteins. The alterations observed within the leukocyte population appear to result from at least two distinct phenomena, both of which must be thoroughly studied. Postflight changes in the coagulation mechanism have not yet been shown.

W84-70527 **199-20-61**
Lyndon B. Johnson Space Center, Houston, Tex.
FLUID AND ELECTROLYTE CHANGE
Carolyn S. Leach 713-483-4086
(199-20-10; 199-20-30; 199-20-50)

Body fluid compartment shifts occur in early exposure to weightlessness. Theses changes are complicated by losses in electrolytes (sodium, potassium, calcium, phosphorus, magnesium and chloride) occurring at a slower rate over mission duration which further influence fluid distribution. Hormonal responses are elicited to counteract these changes. The purpose of this program will be to study these changes and their effect on man's (astronaut and non-astronaut) ability to function in space. Results of the investigations in this RTOP will provide an understanding of the physiological and biochemical effects of weightlessness and rationale for nutritional and/or other countermeasures for use in future space flight missions. The information gained from exposure of man to weightlessness flight for periods approaching 3 months has shown that fluid and electrolyte metabolism has been altered in all crewmen studied. It is apparent that the changes experienced are multiphasic and are caused not only by the weightless environment but also by conditions related to the preparation for flight, the activity during flight, and the recovery procedures.

W84-70528 **199-20-62**
Ames Research Center, Moffett Field, Calif.
FLUID AND ELECTROLYTE CHANGES
L. C. Keil 415-965-6378
(199-20-61)

The primary objective of this RTOP is to investigate and characterize the physiological mechanisms responsible for inflight changes in fluid/electrolyte homeostasis. Once the mechanisms are known, appropriate administration of dietary or hormonal agents during flight may be used to restore or prevent excessive fluid/electrolyte loss. To investigate the fluid/electrolyte mechanisms affected by headward fluid shifts, data will be obtained from human subjects exposed to either horizontal or head-down bedrest. In addition, the effects of water immersion and lower body positive pressure (anti-G suit) will be studied. These investigations will focus on changes in salt/water balance and those hormones that regulate this balance. These data will be analyzed and compared to those generated in animals subjected to similar episodes of blood redistribution in an effort to define the responsible mechanisms.

W84-70529 **199-20-71**
Lyndon B. Johnson Space Center, Houston, Tex.
RADIATION EFFECTS AND PROTECTION
D. S. Nachtwey 713-483-5281

This RTOP discribes a long-program of research to examine the nature of the space ionizing radiation environment and determine its consequences for manned space operations. While currently available information is sufficient for early shuttle missions, research priorities of the attached program are based on the assumption that NASA's long-term plans will involve man in geostationary orbit before the year 2000. Based on knowledge obtained from previous research under this RTOP, exposure to ionizing radiation may be the limiting factor in both mission and career durations for space workers. Shielding considerations, based upon radiobiological responses, may influence significantly the detailed design and total mass of a spacecraft, especially for protection from solar particle events. To provide timely solutions to these problems in the mission planning stage, the underlying research must be conducted now. A plan is presented for research in specific areas of radiobiology and radiation dosimetry. Specific attention is given to the effects of HZE particles of space since the problem is unique to NASA. A coordination effort with other NASA RTOP's and programs of related government agencies will augment the information required by NASA in its long-term radiation research effort.

W84-70530 **199-20-72**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL EFFECTS OF PARTICLE RADIATION
D. E. Philpott 415-965-5218
(199-20-71; 199-20-76)

This program is designed to provide information required to help assess the hazard to man posed by exposure to high atomic number and energy (HZE) particles during spaceflight. The objectives of the research program are to determine: (1) the short- and long-term effects on biological specimens of HZE particle exposure; (2) the threshold exposure dose which induces short- and long-term deleterious effects on organisms; and (3) the particular organs and tissues damaged, the nature of the damage, and the processes which lead to the damage. Experimental animals are exposed to HZE particles at the Lawrence Berkeley Radiation Laboratory or other suitable facility. The animals are periodically examined during the post-irradiation period using biochemical, physological, histological, behavioral and morphometric methods. Life span studies are conducted in animals following low dose irradiation. The rate of aging in selected tissues and organs is determined by cytochemical techniques using both light and electron microscopes. The HZE radition dose required for biological changes is related to the dose of X-rays required to produce similar alterations and, in so doing, the Relative Biological Effectiveness (RBE) of HZE particles is determined.

W84-70531 **199-20-76**
Langley Research Center, Hampton, Va.
RADIATION EFFECTS AND PROTECTION
P. F. Holloway 804-865-2893

To provide basic protection data and analytical methods for use in assessing optimum dosimetry requirements, human perfor-

mance factors, impact on mission objectives, and anticipated exposures in various body tissues as input to radiobiological studies (especially in connection with high energy heavy ions). Particular attention will be given to calculating buildup factors for protons, developing multilayered electron shielding methods, furthering the heavy ion transport theory, evaluating basic environmental data for human protection problems, evaluating self-shielding factors, and analyzing protection requirements in Earth orbit as input to mission planning exercises. The Langley Research Center will maintain a basic research effort in this area. Both the needed expertise and computer facilities required are available at LaRC. New analytical methods will be developed for radiation transport which are amendable to mission analysis, and for use in shield optimization procedures. Theoretical models of the nuclear reaction of heavy ions ae being developed, and complementary experiments are being performed in cooperation with the DOE. Extensive reviews and evaluations of existing reaction data and theoretical models will be made for the generation of libraries of evaluated data and calculational techniques. The development of the necessary reaction data base and calculational models must precede the application to specific NASA programs.

W84-70532 **199-20-82**
Ames Research Center, Moffett Field, Calif.
HUMAN BEHAVIOR AND PERFORMANCE
R. M. Patton 415-965-5000

The three objectives to this research program are: (1) to develop selection, training and performance monitoring procedures which are appropriate to crews involved in manned space missions; (2) to determine the best composition and structure of groups engaged in the various potential types of long-duration spaceflight; and (3) to develop procedures to prevent performance decrements and to remedy those that do occur as a result of the environmental and operational conditions of spaceflight. Individual and group performance will be studied in laboratory and field (real-world) situations which simulate one or more of the conditions associated with long-duration manned spaceflight. Personal, group, procedural and situational characteristics which may be predictive of effective or ineffective performance will be examined. Of particular importance will be studies of the interaction of individuals with various personality traits as they are brought together in the laboratory, or exist in already constituted task-oriented groups, in accomplishing the goals of the group. Work will be continued in the effects of desynchronization of body rhythms on individual performance. Work will be initiated on the effects of altered gravity states on perceptual and motor performance.

W84-70533 **199-20-84**
Jet Propulsion Laboratory, Pasadena, Calif.
HUMAN BEHAVIOR AND PERFORMANCE
John D. Hestenes 213-354-2961

The object of this research is to investigate: (1) the physiological basis for evoked magnetic field responses; (2) the physiological basis for evoked potential responses; and (3) neuromagnetometer instrumentation and methods for using evoked responses for assessment of human performance, neuro-vestibular function and the space adaptation syndrome. The objective is to develop methods for directly measuring on humans the effect induced on cognitive/perceptual processes by exosure to microgravity, cognitive workload stress and environmental conditions or hazards during space operations. It is well known that there are several early physiological adjustments in microgravity, including headward fluid shifts, vestibular dysfunction, motion sickness and other changes which may affect cardiovascular, vestibular and psychological behavior and performance. It is also accepted that human cognitive and perceptual processes vary under various sensory and perceptual task workloads. It is desirable, in the short-term, to have quantitative methods and criteria for monitoring and managing the work roles of humans in space and in simulated environments. It would also be desirable to known whether task workloads under environmental conditions in space, including long-term isolation, may be predictive of long-term stress-related physiological or psychological alterations. Subjects will perform visual and auditory tasks and the event-related responses will be measured and mapped in space and time using a large number of scalp electrodes and a new, highly sensitive neuromagnetometer. Sensitive ultrasound probes will be used to measure skull and scalp thickness for corrections to source localization calculations from the electric potential maps. Source localization by the electric potential and magnetic field methods will be assessed and compared in a cognitive workload assessment study. Research and development will be performed on new neuromagnetometer systems consisting of miniaturized single and array probes using new DC SQUID technology and cascaded Joule-Thomson closed-loop refrigerator technology. This research will lay foundations for instruments and appropriate for simulators and space environments.

W84-70534 **199-20-92**
Ames Research Center, Moffett Field, Calif.
GENERAL BIOMEDICAL RESEARCH
A. D. Mandel 415-965-5061
(199-20-91)

This program is designed to support preliminary studies in areas not specifically covered by any of the major problem oriented RTOP's. If the results of preliminary studies prove to be relevant and of interest to the overall goals and objectives of the Biomedical Research Program, the research will be transferred to one of the major RTOP's for a more thorough study. Mice and rats are suspended in a model which simulates certain physiological responses to space. These experimental animals are then examined for their response to selected parameters of the immune system and to certain infectious agents. The mechanisms of the control and regulation of neurotransmitters, especially the role of certain amino acids in blood pressure control and serotonin production will be studied. It has been hypothesized that spaceflight leads to insulin insensitivity; the mechanisms underlying this insensitivity will be examined. In addition, an effort to study insulin insensitivity using a mathematical model will be initiated.

W84-70535 **199-20-94**
Jet Propulsion Laboratory, Pasadena, Calif.
GENERAL BIOMEDICAL RESEARCH (QUANTITATIVE ULTRASONIC EVALUATION OF DECOMPRESSION)
J. A. Rooney 213-354-3942

The basic objective is the development of swept-frequency ultrasonic techniques that are capable of quantifying the onset or development of decompression sickness in NASA flight personnel. The specific objectives include (1) development, characterization and optimization of swept-frequency ultrasonic techniques utilizing transmission, reflection, harmonic and phase-detection technologies to exploit resonant properties for quantification of bubbles in biological systems; (2) determination of the necessary design parameters for an ultrasonic system for imaging and quantifying bubble populations and dynamics; (3) determination of the acoustic parameters of bubbles in biological systems in the size range of interest to NASA investigators; (4) determination of the feasibility of utilizing swept-frequency ultrasonic systems for quantifying bubble dynamics and bubble population interactions; and (5) development of, in collaboration with other NASA investigators, the basic design criteria for ultrasonic techniques for use in studies and monitoring of decompression sickness. The objectives will be met by the modification and development of the unique JPL swept-frequency ultrasound system. Transmission, reflection, harmonic, and phase-detection techniques will be developed and compared for sensitivity and resolution. Measurements will be made of the acoustic parameters of bubbles needed both for quantification of their population statistics and for determining future system design parameters. Theory will be modified to describe bubbles in biological media in the size range of interest. Consultations and collaborations with other NASA investigators will be developed and used to determine desired system parameters.

W84-70536 **199-20-96**
Langley Research Center, Hampton, Va.
NOISE AND VIBRATION CRITERIA FOR LONG-DURATION MANNED SPACE MISSIONS
H. G. Morgan 804-865-3577

The objective of this research is to develop an understanding of noise and vibration effects on the crew during long duration space missions. The goal is to develop noise and vibration criteria for space vehicle habitability which includes the ability to communicate, perform tasks, and sleep. The approach is to conduct in-house and grant research to extend existing Earth-based habitability criteria to a space-based habitat which includes weightlessness, reduced pressure, and long-term confinement. Test chambers for producing the combined noise and vibration for such testing are presently available. In addition, previous space flights as well as future missions may be utilized for valuable data and testing. Emphasis will be on studies wherein subjects are exposed to noise and vibration stimuli representative of the range of stimuli to be encountered on space missions. These stimuli, based on measurements in previous space vehicles, are unique and consist of intermittent machinery noise and vibration which is superimposed on ambient noise in a reverberant cabin. Effects of the noise and vibration will be assessed through physiological measurements of sleep disturbance (EEG), hearing decrements (TTS), and communication interference, as well as subjective measures. Also of interest is the effect of zero gravity on hearing. Physiological correlates of performance affected by auditory and vibratory stimuli will also be investigated. These data will then be extrapolated to include the effects of acceleration, reduced pressure, and long-term confinement through laboratory testing of human subjects and through application of limited data from related situations. Results will be directly usable for the formulation of habitability criteria and specifications.

W84-70537 **199-30-12**
Ames Research Center, Moffett Field, Calif.
GLOBAL BIOLOGY MODELLING
J. G. Lawless 415-965-5220

The objective is to achieve quantitative understanding of the chemical interactions between the biosphere and the atmosphere. This is accomplished through the use of comprehensive models of gas phase and particle phase atmospheric chemistry and physics. The fluxes of biologically produced materials into the atmosphere will be quantified and their subsequent conversion rates and removal rates will be determined. In addition the fluxes of atmospheric gases and particles into aqueous and terrestrial reservoirs will be simulated in order to quantify their potential effects on biota. Existing computer models will be used to investigate the chemistry and physics of biologically generated compounds. Verifying data on the conversions which occur will be obtained through interaction with experimenters. Chemical species which have significant biological sources or significant impact on biota have been identified for specific modelling investigations.

W84-70538 **199-30-22**
Ames Research Center, Moffett Field, Calif.
ATMOSPHERE/BIOSPHERE INTERACTIONS
J. G. Lawless 415-965-5220

To address the characterization of biologically mediated atmospheric gas fluxes, the identification of biological sources and sinks of atmospheric trace gases, and the elucidation of those factors that influence these biogenic gas flux magnitudes. To study the influence of biological processes on climate, atmospheric composition, radiative transfer, and biogeochemical cycling. The magnitude of the biogenic component of the sulfur cycle in the coastal marine environment will be studied. The relationship of the magnitude of these biogenic emissions to regional processes via remotely sensed data will be established. Aerosol residence times and coefficients of air-sea and free troposphere boundary layer gas exchange, which are of critical importance in quantifying atmospheric cycles, will be determined.

W84-70539 **199-30-26**
Langley Research Center, Hampton, Va.
BIOSPHERE-ATMOSPHERE INTERACTIONS IN WETLAND ECOSYSTEMS
Robert C. Harriss 804-865-2861

The research plan consists of two elements one of which concerns the biogenic modulation of methane in the global troposphere: the role of wetlands. Wetlands are hypothesized to be the major natural source of methane to the troposphere. A detailed investigation of microbiological, ecological, geochemical, and physical factors controlling methane emissions from soil and water interfaces in the atmosphere in wetland habitats will be conducted. Methane emissions will be quantified at a wide variety of swamp, salt-marsh, and peat bog sites in eastern North America and Central America. These studies of methane flux in specific habitats will be coupled to remote sensing measurements of ecosystem properties to develop capabilities for extrapolation of in situ measurements as regional and global biogeochemical fluxes. The second element concerns remote sensing for the ecological assessment of tidal wetlands. The proposed research effort will explore the application of multispectral radiance measurements to assessment of biogenic mediation of the global carbon cycle by tidal wetlands. The objectives will be to investigate remote sensing capabilities to studies of phytosynthetic fixation of atmospheric carbon by tidal wetlands plants, production, and flux of biogenic methane from wetland soils, and concentrations and flux of organic carbon compounds and methane in tidal waters. Assessment of these processes is hypothesized to be accessible to remote measurement of: (1) biomass and productivity of the emergent macrophytic vegetation; (2) canopy characteristics of emergent wetland vegetation and their relationship to production and flux of biogenic methane; (3) organic carbon compounds in tidal creeks draining wetland areas.

W84-70540 **199-30-31**
Lyndon B. Johnson Space Center, Houston, Tex.
TERRESTRIAL BIOLOGY
F. G. Hall 713-483-4505

In this research, we propose to investigate the use of satellite remote sensing data to estimate leaf area index, biomass, and net primary productivity in support of Global Habitability studies. Specifically, we propose to test the hypotheses that leaf area index, biomass, and net primary productivity can be estimated to an accuracy of + or - 20% within major ecological regions, using satellite remote sensing. To accomplish this, we will first develop and evaluate in-situ techniques to acquire sufficiently accurate ground measurements of leaf area index, biomass, and net primary productivity, since current techniques for measuring these quantities with adequate accuracy are not practically affordable. We will then use these improved techniques to acquire sufficiently accurate measures of leaf area index, biomass, and net primary productivity during the 1983 growing season. We will acquire these data, along with field, aircraft and satellite spectral data over a boreal forest site. With the above data base, we will use both empirical curve fitting techniques and canopy reflectance models to develop functional parametric relationships between various spectral transforms (e.g., ratios and linear transforms) and leaf area index, biomass, and net primary productivity. We will then evaluate the accuracy of predictions from these relationships when used as estimators on independent data sets. We will, in addition, examine the sensitivity of these estimators to various background effects such as soil background, seasonal effects, atmospheric effects, etc. We will examine both single and multidate spectral data as well as the visible, reflective and emissive infrared, and microwave bands available on the LANDSAT 4 multispectral scanner, thematic mapper, or potentially available future sensors.

W84-70541 **199-30-32**
Ames Research Center, Moffett Field, Calif.
TERRESTRIAL ECOLOGY
J. G. Lawless 415-965-5220
(677-21-31; 656-11-01)

To characterize the rates and pathways of nutrient transfer

within and between terrestrial ecosystems. To use remotely sensed data, coupled with ground based research, to improve our estimates of biomass pool size and distribution, rates of change, and productivity in terrestrial ecosystems. To understand, measure and model the biogeochemical cycling of the elements N, C, S and P in the terrestrial environment. These data will be used in conjunction with Geographic Information System Technology to further explore and define the relationships among the data. Ground based and remote sensing techniques are used to relate estimates of species and structural variables to net primary productivity, net assimilation rate, and total biomass accumulation, and biogeochemical cycles. The statistical relationship between the spatial variation of remotely sensed information and the temporal/spatial variation in these biological variables is determined. The transfer of major and minor biologically produced carbon and nitrogen compounds between terrestrial ecosystems and global reservoirs are identified and measured. The results of the above studies are incorporated into predictive models of biogeochemical cycles.

W84-70542 **199-30-34**
Jet Propulsion Laboratory, Pasadena, Calif.
BIOGENIC ORIGIN OF METHYL CHLORIDE
M. N. Dastoor 213-354-7429
(147-21-09)

The role of the biota in the maintenance and modulation of the major constituents of the atmosphere (i.e., N2, O2, CO2) is well established. In contrast, the biotic interactions involving trace atmospheric constituents are unknown. Of particular importance, is the atmospheric ozone layer. The objective of this proposal is to perform a study to evaluate the contribution of certain marine algae (i.e., Macrocystic pyrifera), which evidence suggests should be involved in the production of methyl chloride. Marine macroalgae may produce methyl chloride by direct biosynthesis, by producing an intermediate compound which is chemically converted to methyl chloride in seawater, or by supplying, after death, certain metabolites for microbial degradation. An understanding of the natural production of methyl chloride is required to construct a suitable atmospheric halogen budget and to determine its contribution to atmospheric ozone destruction. We propose to identify the marine algae species which are responsible for methyl halide production. If an indirect mechanism of methyl halide production is required, then we will investigate the possibility that non-photosynthetic and/or methanogenic bacteria may utilize certain marine algae to produce methyl halides. The production of methyl halides will be quantified and a correct atmospheric halogen budget based on the results will be constructed. Our approach will employ laboratory culturing of marine algae and methanogenic bacteria, and quantitative chemical analysis. Quantitative field measurements of marine kelp bed (Point Loma, CA) known to have elevated levels of methyl chloride will also be conducted.

W84-70543 **199-30-36**
Langley Research Center, Hampton, Va.
TERRESTRIAL BIOLOGY RPN 250483
David S. Bartlett 804-865-4345

The objectives are to investigate remote sensing capabilities in studies of photosynthetic fixation of atmospheric carbon by tidal wetland plants and production and flux of biogenic gases from wetland soils. Assessment of these processes is hypothesized to be accessible by remote measurement of biomass and productivity of the emergent macrophytic wetland vegetation; canopy characteristics of emergent wetland vegetation and their relationship to production and flux of biogenic gases. In-situ radiometry will be used to characterize upwelled radiance of the vegetation canopy in LANDSAT MSS and thematic mapper spectral bandes. These data will be correlated with concurrent biometric analysis of the vegetation and measurements of methane flux made by the 'Biogenic Modulation of Tropospheric Methane' study group. Computer simulation of radiative transfer in vegetation canopies will supplement field measurements through quantitative examination of relationships observed in the field and through extension of analysis to situations not encountered in the field sites. Digital multispectral image analysis will be applied to available aircraft and LANDSAT scanner data to test assumptions and conclusions derived. Field sites in Virginia and South Carolina will be sampled periodically by LaRC personnel.

W84-70544 **199-30-42**
Ames Research Center, Moffett Field, Calif.
OCEAN ECOLOGY
J. G. Lawless 415-965-5220

The objectives of this RTOP are to address the determination of ocean productivity, biomass pool size and distribution, and the characterization of the influence of biological processes on ocean dynamics as well as to understand the biogeochemical cycles of carbon and nitrogen in the marine coastal zone. Stable isotopic abundances in contemporary aquatic carbon and nitrogen pools are related to carbon and nitrogen flux, transfer, and storage processes. Stable isotopic abundances in selected sedimentary carbon and nitrogen pools will be related to the history of the biogeochemical cycling of these elements. The data obtained from these studies will be incorporated into a predictive model of carbon and nitrogen biogeochemistry.

W84-70545 **199-30-52**
Ames Research Center, Moffett Field, Calif.
INSTRUMENT DEVELOPMENT
J. G. Lawless 415-965-5220
(199-50-42; 157-04-80)

The objective is to provide specific information on the chemical composition of the atmosphere and the volatiles in surface and particulate matter on the Earth. This information is essential for selecting or devising the most appropriate model for the biogeochemical cycling of the elements S and N, and will further provide a basis for understanding the conditions that mediate these cycles. Improved methods and instrumentation will be developed for in-situ chemical analyses of the volatile species contained in the atmosphere, surfaces and particulates. Special emphasis is directed to the development of the gas chromatographic approach since it is now proven to be among the most effective means for measuring complex gaseous chemical mixtures. Improvements in the gas chromatography, such as column technology, detector design, and total system design (including work on other subsystems) will be rigorously explored.

W84-70546 **199-40-22**
Ames Research Center, Moffett Field, Calif.
DEVELOPMENT BIOLOGY
J. Miquel 415-965-5952
(199-40-27; 199-40-32)

The general objective of the research described in this RTOP is to identify the effects of gravity and space radiation on plant, insect, and animal development, maturation and senescence, and to examine the evolutionary importance of gravity as a determinant of the functiion and form of terrestrial life. Special attention will be paid to tests of the working hypothesis: the observed effects of exposure to abnormal g on the developmental and aging processes of experimental animals are related to alterations of metabolic rate, and concomitant changes in the rate of production of disorganizing oxygen radicals at the mitochondrial level. The approach is to evaluate, through ground-based and spaceflight experiments, the dependence on gravity of plant, insect, and animal growth, development and function; to assess and understand the mechanisms involved in biological alterations and adaptations induced by gravity and ionizing radiation; and to evolve concepts, design experiments and establish baseline data for future inflight fundamental research.

W84-70547 **199-40-24**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENTAL BIOLOGY - RESPONSE OF DEVELOPMENT AND REPRODUCTIVE PROCESSES IN HIGHER PLANTS AND A METAZOAN SUBJECTED TO SPACE-LIKE ENVIRONMENTS AND MODIFIED GRAVITY
Takashi Hoshizaki 213-354-6962

The objectives of this RTOP are to determine and characterize

the development and reproductive processes of higher plants and a metazoan under weightlessness and modified gravity environments to gain new insight on gravity's role in the initiation, development and maturation of plant and animal organs and organ systems. Information on the effect of multiple generation exposure to modified gravity on developmental stages and on survival rates will be sought. A better understanding of gravity's role in growth and development would allow: (1) in the case of plants, the enhancement of plant productivity through specific environmental and metabolic controls and by biochemical modifications; and (2) in the case of the nematode, a better understanding of direct gravity effects on embryogenesis and micro-gravity's modulating effects on radiation-induced lesions. The approach: in case (1) is to use whole plants of Arabidopsis thaliana and Cardamine oligosperma. The former is a classic example of a plant that has a short life cycle (45 days). Studies will be made on the development and viability of various organs of plants grown in earth gravity modified by a clinostat and under weightlessness in space. The approach: in case (2) is to use whole animals of Caenorhabditis elegans, a nematode that can be easily cultured by the thousands in petri dishes. Studies will be made on the potentiating or corrective effects of gravity on embryogenesis and male behavior as well as on the development of several selected organs and activity patterns modified by radiation. Ground based studies are to be correlated to flight studies.

W84-70548 **199-40-32**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL ADAPTATION
E. M. Holton 415-965-5471
(199-40-10; 199-40-20)

The overall aims of this research program are: (1) to increase understanding of biological processes as they are affected by the unique environment of space; (2) to identify and assess the biological mechanisms by which living systems evolve, respond, and adapt to spaceflight environmental parameters (particularly altered gravity), as well as the interactive effects of gravity and other stimuli and stresses on the physiology and metabolism of organisms; and (3) to determine functional variations and regulating mechanisms at all levels of biologic organization (plants, invertebrates, and vertebrates) using gravity as a tool to yield new understanding about living systems on Earth. Biochemical, physiological, and anatomical changes in organisms exposed to altered gravity will be delineated and quantified. Altered gravity states will be introduced by means of simulated weightlessness (rodent suspension systems), acceleration (centrifuge), or clinostats. Morphologic changes, modified biochemical pathways, and changes in specific physiological functions will be assessed in terms of exposure intensity and duration. A significant part of this effort will elaborate on the regulatory factors in homeostatic adaptation to and deconditioning from the metabolic stress associated with a change in the gravity field.

W84-70549 **199-50-12**
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION
S. Chang 415-965-6206
(199-50-32; 199-50-42)

The objective of research in chemical evolution is to understand the physical-chemical pathways followed by both inorganic and organic matter in the solar system which led, in the case of Earth, to the emergence of life, but which in extraterrestrial environments took divergent paths. The approach taken to meet the objective involves primarily both laboratory and computer experiments designed to simulate various physical-chemical processes that occurred putatively on the primitive Earth or other bodies (e.g., outer planets, meteorite parent bodies) at either macroscopic or microscopic scales. These processes are studied and the chemical outcomes elucidated for the purpose of obtaining data on rates of chemical reactions, abundance of products, and chemical and physical composition of products. These data provide the input necessary for the development of self-consistent models that describe, in a geophysical-geochemical context, the pathways by which the molecular constituents necessary for the origin of life and the systems bearing rudimentary attributes characteristic of living systems evolved from abiotic milieux.

W84-70550 **199-50-22**
Ames Research Center, Moffett Field, Calif.
ORGANIC GEOCHEMISTRY
D. J. Des Marais 415-965-6110
(199-50-12; 199-50-42)

This work seeks to understand the origin and early evolution of life on Earth through studies of organic matter in ancient rocks, contemporary environments, and microorganisms. In practice, the objective is to elucidate the chemical relationships between sedimentary organic matter and the biosphere from which it derives. The specific objective is to understand the origin of stable isotopic patterns in sedimentary organic matter. Because sedimentary stable isotopic abundances are influenced by microbial biochemistry and also are well-preserved in ancient rocks, their study complements more traditional methods of early evolution research. Stable carbon and nitrogen isotopic fractionation in microbial metabolism will be examined. Using this knowledge, isotopic fractionation in biogeochemically significant microorganisms will be investigated to learn how they impose their chemical and isotopic signatures upon the organic constitutents of rocks. Through field studies, these signatures in contemporary environments will be related to their analogs in ancient fossils and sediments.

W84-70551 **199-50-32**
Ames Research Center, Moffett Field, Calif.
ORIGIN AND EVOLUTION OF LIFE
L. I. Hochstein 415-965-5938
(199-50-12; 199-50-42)

The objectives are to explore the mechanisms, processes, and environments associated with the origin(s) and evolution of life on Earth and to ascertain to what extent they represent constraints within which life can develop elsewhere in the Universe; and to utilize such information to design models lending themselves to experimental verification. The origin of life represents a point on a conceptual continuum that characterizes the physical, chemical, and biological evolution of matter. While experimental verification of hypotheses concerned with cosmological and chemical evolution can be carried out on the extraterrestrial stage, studies on the origin and evolution of life are limited to the only experimental material available, terrestrial life. Several crucial areas of study have been identified for extensive investigation from which first principles can be discerned and applied to the formulation of a theory for the origin and early evolution of life. Two approaches are adopted for studying biogenesis and bioevolution: one is to posit plausible models for relevant processes and environments, and test them either experimentally or by the use of computer simulations; the other is to identify early events and their evolutinary context in contemporary organisms since they are, in fact, repositories of information concerning what took place during the evolution of life.

W84-70552 **199-50-42**
Ames Research Center, Moffett Field, Calif.
SOLAR SYSTEM EXPLORATION
G. C. Carle 415-965-5765
(199-50-12; 199-50-22)

The objective is to provide specific information on the chemical composition of the atmospheres and the volatiles in surface and particulate matter of solar system bodies including planets, their satellites, comets, asteroids, meteorites and particulate matter in space. This information is essential for selecting or devising the most appropriate model for the evolution of the solar system and for each of the investigated bodies, and will further provide a basis for understanding the conditions necessary for the origin of life by comparisons of the evolution and the chemistries of these bodies. Improved methods and instrumentation will be developed for in situ chemical analyses of the volatile species contained in atmospheres, surfaces and particulates. Special emphasis is directed to the development of the gas chromatographic approach

since it is now proven to be among the most effective means for measuring complex gaseous chemical mixtures. Improvements in the gas chromatography, such as column technology, detector design, and total system design (including work on other subsystems), will be rigorously explored.

W84-70553 **199-50-52**
Ames Research Center, Moffett Field, Calif.
LIFE IN THE UNIVERSE
J. Billingham 415-965-5181
(199-50-12; 199-50-22; 199-50-32)

The goals are to understand the history of the biogenic elements in the galaxy, in the solar system, and during the early evolution of the Earth; to study possible evolutionary pathways for complex life; and to examine the influence of astrophysical, stellar and solar system events on the evolution of complex life on Earth. This RTOP has two distinct parts: the history of the biogenic elements, and the evolution of complex life. In each part, a series of Science Workshops has explored the major scientific questions, to determine which are amenable to theoretical, experimental or observational approaches, and to recommend the major elements of a research program to pursue those objectives. The recommendations of the Science Workshops will be incorporated into proposals for research in both areas. Each area will include some preliminary tasks which will assist in the crystallization of the program or which are cogent examples of the type of research appropriate for the two areas. As the program expands in each area over the next two fiscal years, FY-84 and FY-85, it may be appropriate to split this RTOP into its two major components.

W84-70554 **199-50-62**
Ames Research Center, Moffett Field, Calif.
THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)
J. Billingham 415-965-5181

This RTOP supports the development and implementation of the SETI element of the NASA OSSA Life Sciences Division Exobiology program entitled 'Life in the Universe'. The SETI program is an R & D effort which has the following five objectives: (1) to conduct an extensive five-year R & D efffort to determine the most cost effective way to do SETI and to carry out limited but significant SETI observations; (2) to design, build, and test a SETI prototype system; (3) to use the prototype at Goldstone and Arecibo for initial SETI observations; (4) to evaluate the SETI system for its value for radio astronomy; and (5) to explore new technologies for SETI. In accomplishing these objectives, telescope-SETI hardware interfaces will be determined, alternative observational techniques investigated, and various signal processing and identification methods examined in software and optimized for implementation in hardware. Signals of natural and artificial origin will be sought over portions of the sky between 1 and 10 GHz up to a maximum sensitivity of 10 to the -23 power/sq Wm, and selected solar-type stars will be searched in the 1 to 3 GHz range up to a maximum sensitivity of 10 to the -27 power/sq Wm. These initial observations are expected to continue through 1987. The plan is divided into six hardware phases, each of which improves the prototype capability.

W84-70555 **199-60-11**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED LIFE SUPPORT SYSTEMS
Richard L. Sauer 713-483-2759

The objective of this program is to identify the requirements and to develop the technology that will be required to provide the life and metabolic support systems for the next generation, long duration, manned space missions. These life support systems include atmosphere revitalization and control, water reclamation and supply, hygiene and waste management, and food service and supply. This RTOP covers the research, development, and testing support systems, and includes the development program recommended by the Space Station Technology Working Group. This RTOP will include the effort required to support the development of the life support systems for an extended duration orbital space vehicle, and in many instances, will culminate with the fabrication and testing of flight prototype hardware. Following system concept identification, technology gaps and needs will be identified to permit timely investigation and solution. It is to this and the accompanying development to subsystem concepts, procedures, and developmental hardware that the initial effort will be directed.

W84-70556 **199-60-12**
Ames Research Center, Moffett Field, Calif.
ADVANCED LIFE SUPPORT SYSTEMS
P. D. Quattrone 415-965-5733
(506-64-31; 199-60-22)

The objective of this program is to advance the technology base for regenerative life support systems required to support long-term manned space missions. The system functions to be investigated include: air revitalization, water reclamation, control/monitor instrumentation, and solid waste management. Specific life support subsystem technology areas will be investigated (feasibility and/or development). This RTOP will be directed toward advancing the technology and/or hardware development status for advanced life support subsystems and will result in achieving a research and hardware development technology base for subsystems that have the characteristics of low maintenance, high reliability and long life.

W84-70557 **199-60-21**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED EXTRAVEHICULAR SYSTEMS
Richard E. Mayo 713-483-4933

The objective of this RTOP is to develop the technology necessary to provide a high mobility, regenerable EVA system that will maximize the efficiency of EVA for servicing Shuttle payloads and for support of Space Station-related activities. The approach involves: (1) defining EVA design standards and criteria to assure design compatibility between evolving EVA equipment and satellites/vehicles; (2) the development of prototype PLSS (Portable Life Support System) hardware incorporating a higher degree of automation and less dependence on expendables for thermal control and CO2 removal; and (3) the development of a high mobility spacesuit capable of higher operating pressures.

W84-70558 **199-60-22**
Ames Research Center, Moffett Field, Calif.
ADVANCED EXTRAVEHICULAR SYSTEMS
H. C. Vykukal 415-965-5386
(199-60-12; 506-64-31)

The objective of this RTOP is to advance the technology base for advanced extravehicular systems required to support long-term manned space missions. The advanced extravehicular systems must provide for efficient and routine EVA capability. This RTOP program will emphasize technology areas that provide: improved hardware performance; increased hardware and system life; reduced manufacturing, maintenance, and operations costs. This RTOP will be directed toward the development of efficient high pressure ($>$ or $=$ 8 psig) suit components that provide for improved EVA capability.

W84-70559 **199-60-42**
Ames Research Center, Moffett Field, Calif.
FOOD REQUIREMENTS, PRODUCTION AND PROCESSING FOR CELSS (CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM)
R. D. MacElroy 415-965-5573
(199-60-52)

The objective of this program is to investigate various methods of utilizing processed waste materials to regenerate food in a Controlled Environment Life Support System (CELSS). Methods of food production that could be employed in controlled environments will be investigated. These include photosynthesis by organisms ranging from algae to higher plants, and physicochemical methods, such as photoreduction of CO2. In the latter case, reduced organics could be fed to non-photosynthetic

organisms, such as yeast and bacteria, which could be used as human food materials after appropriate processing. During the early phases of the program, investigation of higher plants will be emphasized. Research will be concentrated on plant nutrient requirements; stability and reliability of production, including toxin production and characterization; controllability of growth; and variation in food nutrient value. Plants will be selected and evaluated through growth and product analyses in a simulated CELSS environment. Plant production techniques will be identified, evaluated, and developed. Candidate plants and methods will be tested in a simulated CELSS environment in conjunction with waste management and systems management developments.

W84-70560 **199-60-44**
Jet Propulsion Laboratory, Pasadena, Calif.
UNCONVENTIONAL FOOD SYNTHESIS FOR CELSS
G. R. Petersen 213-354-7019
(199-60-64; 199-40-30)

The objective of this RTOP is to develop unconventional food production systems that are alternatives to higher plants as the primary food source in a controlled ecological life support system. Unconventional food systems offer redundancy, the possibility of reduced weight/volume requirements, rapid reconstitution in event of failure, and more efficient use of energy. The candidate systems include direct chemical synthesis of food and time microbial production of nutrients from simple chemical sources and/or more complex waste streams. One promising unconventional system is a hybrid chemical/biological system in which the virtues of process control and well defined systems provided by a chemical step are combined with the specificity of food production offered by a biological step. Such a system is being investigated and involves the photoelectrochemical and photochemical production of simple one to three carbon organics suitable for use as feedstocks for microbial food production. The chemical and biological processes that are particularly suited for a CELSS environment will need to be emphasized and investigated.

W84-70561 **199-60-52**
Ames Research Center, Moffett Field, Calif.
WASTE MANAGEMENT FOR CELSS
T. Wydeven 415-965-5738

The objective is to plan and conduct the research and develop the technology required to process wastes so as to produce the nutrients necessary for regenerating food in a Controlled Ecological Life Support System (CELSS) for space applications. Models of the waste materials to be processed by the waste management system in a CELSS for use in space will be developed. Exploratory studies will be undertaken of each of the major waste management technologies that have been identified to date as candidates for CELSS. The candidate methods are wet oxidation, incineration, aerobic and anerobic biological oxidation. Emphasis in the exploratory studies will be placed on determining the adaptability of a given waste management method to producing a product that can be used subsequently to regenerate food. Inherent in this approach is investigation of methods to remove and separate organic and mineral components of the effluent.

W84-70562 **199-60-62**
Ames Research Center, Moffett Field, Calif.
SYSTEMS MANAGEMENT, CONTROL, AND ECOLOGICAL CONSIDERATIONS FOR CELSS (CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM)
R. D. MacElroy 415-965-5573
(199-60-42; 199-60-52)

The objectives are: to identify and investigate biological functions in isolated autonomous systems (CELSS) that must be controlled to achieve stable system operation; to identify and investigate control parameters in biological, chemical and mechanical systems; identify parameter coupling and develop control strategies; and to establish and maintain communication and cooperation among investigators in the CELSS Program. The approach used in this RTOP is to develop theoretical and/or experimental investigations of significant problems affecting CELSS system operation, control and stability. In addition, because this work intersects other CELSS investigations in the areas of food production (199-60-42) and waste management (199-60-52), certain tasks address problems of promoting an integrated CELSS research program, and supporting continuous communication between program investigators and program managers.

W84-70563 **199-60-64**
Jet Propulsion Laboratory, Pasadena, Calif.
ANALYTICAL MONITORING AND CONTROL IN A CELSS
Charles E. Giffin 213-354-2494
(199-60-44; 199-60-54)

This RTOP supports the development of the monitoring and control technology base required for the design of Controlled Ecological Life Support Systems (CELSS). The monitoring needs of such systems will be extensive and must be fulfilled under strenuous constraints that include high precision, reliability, versatility, specificity, rapidity of analysis, and ability to interface with a control system. All of this must be accomplished under conditions of minimal environmental impact, limited weight and volume requirements, as well as prolonged and economic operation. The approach taken in this RTOP is to: (1) initially identify generic monitoring and control requirements for CELSS that will be refined in an iterative manner as various CELSS scenarios are constructed by program investigators; (2) design an integrated, automated instrument system centered about a miniaturized mass spectrometer with an Electro-Optical Ion Detector (EOID); and (3) develop appropriate analysis protocols. Mass spectrometry is one of the most specific, precise, and sensitive analytical techniques available today. Used with an EOID, it offers single ion detection, and simultaneous detection over a wide mass range with a resultant sensitivity of 10 to the -15th power grams.

W84-70564 **199-60-71**
Lyndon B. Johnson Space Center, Houston, Tex.
MAN-MACHINE ENGINEERING REQUIREMENTS FOR DATA AND FUNCTIONAL INTERFACES
J. L. Lewis 713-483-2845

The objectives of this RTOP are: (1) to move toward quantification of man-machine engineering data, both on the ground and in flight; (2) to continue to pursue state-of-the-art technology and to advance that technology for the purpose of creating more effective and efficient man-machine interfaces for manned spacecraft; and (3) to improve techniques of man-machine engineering design so that innovative steps may be taken toward creating better crew interfaces in future vehicles. A series of continuing tasks will be conducted to identify and implement workable instrumentation packages for acquiring quantitative man-machine engineering data in one-g, simulated zero-g, and actual zero-g. Those efforts currently defined that lead toward definitive design requirements for use as inputs to the Operator Station Design System will be continued and feasibility studies of promising crew interface items will be pursued.

W84-70565 **199-70-12**
Ames Research Center, Moffett Field, Calif.
COSMOS FLIGHT EXPERIMENTS PROJECT
E. W. Gomersall 415-965-5730

The objectives of this effort are to determine the effects of spaceflight on a wide range of biological specimens; to use hypogravity as a tool to study fundamental problems in biology which cannot be solved on the ground; to study biomedical problems encounted during manned spaceflight using animal surrogates; to evaluate countermeasures to the deleterious effects of spacelight; to develop and test life sciences equipment and experimental procedures which could be used aboard the US Space Shuttle, Spacelab and Space Station flights; and to stimulate an exchange between US and USSR scientists of information related to spaceflight. Following a Soviet invitation to participate in a spaceflight mission, a Dear Colleague Letter is prepared and released as appropriate. Proposals for experiments are reviewed and a tentative US payload submitted to the Soviets for approval. Experiments selected for flight are funded for a definition phase

preflight and a postflight data analysis phase. Flight and ground support hardware are developed and tested as required. Final reports are prepared and published.

W84-70566 **199-80-32**
Ames Research Center, Moffett Field, Calif.
VESTIBULAR RESEARCH FACILITY (VRF)/VARIABLE GRAVITY RESEARCH
R. W. Mah 415-965-6538

The overall objective is to develop a Vestibular Research Facility/Variable Gravity Research Facility (VRF/VGRF) scientific research program that will permit scientists to conduct fundamental vestibular research using a wider range of experimental stimuli and state of the art hardware capabilities not available elsewhere. Current theories are that the vestibular system is intimately involved with Space Adaptation Syndrome, as it is with terrestrial motion sickness. It is believed that a fundamental understanding of the vestibular system is necessary before a satisfactory prevention or cure can be derived. Emphasis in the VGRF is placed on developing hardware designs for gravitational research and l-g control in space using VRF "core" modules. A ground version of the VRF will be constructed under the guidance of the VRF Science Advisory Committee, and will be housed in a VRF/VGRF Science Facility. This ground equipment includes many, but not all, of the stimulus and recording modes of the flight version. The Science Advisory Committee for VRF feels that this facility presents a unique opportunity to conduct animal and potentially human research concerning vestibular function. This facility will be available for the scientific community to use as described in the VRF/VGRF scientific research program plan.

W84-70567 **199-80-42**
Ames Research Center, Moffett Field, Calif.
LIFE SCIENCES RESEARCH FACILITY FOR SPACE STATION DEFINITION STUDY
R. D. Arno 415-965-6640

The objective of this activity is to determine the best approach to accommodating nonhuman life science investigations on long duration zero-gravity spaceflight. The mission duration limitations of the space transportation system (shuttle) and spacelab do not permit the unequivocal resolution of the various issues in human health and basic biology. Such issues include vestibular changes and space sickness, cardiovascular deconditioning, bone and muscle loss, electrolyte and fluid shifts, animal developmental biology, and plant physiology. The problems of micro-gravity adaptation are being addressed through the methodical identification of science information requirements; the analysis of technology needs and status; and the parametric study of spacecraft systems requirements. Science requirements are being identified through the involvement of scientists of recognized stature in the biological sciences community in workshops, symposia, and professional society meetings. Technology issues and costs are being analyzed under contract. Spacecraft system interfaces and impacts are being defined parametrically for a range of science accommodation capabilities (i.e., different mission durations, various automation levels, etc.). Systems studies are being monitored at MSFC.

W84-70568 **199-80-62**
Ames Research Center, Moffett Field, Calif.
MAMMALIAN DEVELOPMENT FACILITY
M. R. Heinrich 415-965-5761

The objectives of this effort are to provide scientific guidance for the conceptual design and development of a Mammalia Development Facility (MDF) to study early mammalian development; i.e., from fertilization to litter development in micro-gravity environments; to identify design requirements for an MDF; and to evolve and evaluate flight hardware concepts. A Science Advisory Group will be convened to identify science requirements for an MDF. Conceptual designs will be evaluated by the advisory group. Phototypes will be fabricated and tested using procedures suggested by the advisory group.

W84-70569 **199-80-72**
Ames Research Center, Moffett Field, Calif.
PLANT RESEARCH FACILITIES
E. L. Merek 415-965-6745

The overall objectives are to provide scientific guidance for the design and development of general purpose plant research facilities for spaceflight which can be used for the study of plant development, physiology, and growth in a weightless environment; to establish design requirements for flight plant research facilities compatible with spacecraft; and to identify hardware concepts for such designs. A science advisory group will be organized to identify the science requirements for plant experiments in space. These requirements will be used by the engineers to develop preliminary hardware designs which will be subject to the review of the Science Advisory Group. A prototype will be fabricated from the approved design, evaluated and tested using procedures also recommended by the Advisory Group.

W84-70570 **199-90-72**
Ames Research Center, Moffett Field, Calif.
AMES RESEARCH CENTER INITIATIVES
H. P. Klein 415-965-5094

The mission of the Life Sciences Directorate at Ames Research Center is to understand the origin of life on earth and to search for life elsewhere in the universe, to understand the effects of space flight upon humans and other forms, and to provide environments and equipment in spacecraft that will permit crews and passengers to exist safely and perform effectively. The Center Initiatives RTOP provides the appropriate flexibility in the alternative life sciences research and technology efforts which may result in formal research proposals ultimately becoming part of an approved RTOP. The Director of Life Sciences, ARC, will review the proposed efforts and select the tasks which will become part of this RTOP. Those tasks which show potential for further research pursuit will subsequently be submitted for future review and approval in the appropriate problem oriented RTOPs.

Data Analysis

W84-70571 **385-38-01**
Goddard Space Flight Center, Greenbelt, Md.
SOLAR PHYSICS DATA ANALYSIS AND OPERATIONS
Robert D. Chapman 301-344-6184

This effort proposes to: (1) process, analyze and interpret solar data from flight projects and to continue this work after the initial funding from project offices has been terminated; (2) publish in the scientific literature detailed studies of phenomena gathered over protracted periods of time which reveal long-term features and correlation effects not evident during the prime data analysis; (3) engage in multidisciplinary studies comparing experimental data from other satellites and/or ground based laboratories in order to investigate in fine detail, fine structure, long term and secular efforts; and (4) provide additional reduced, analyzed data for archive in the National Space Science Data Center. During the prime analysis period many theoretical ideas about the observed phenomena are developed and correlations of the data with other ground-based or satellite data are suggested. In addition, to study a given phenomena over an adequate range of the important independent variables such as solar region, wavelength, solar cycle, etc., it is necessary to process large quantities of data covering extended periods of time. Thus, additional data will be processed and analyzed, multiexperiment studies will be made and various proposed models or theories will be critically tested by use of these data. Ground-based spectroheliograph measurements will be correlated with satellite observations.

W84-70572 **385-38-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR AND HELIOSPHERIC PHYSICS DATA ANALYSES
M. Neugebauer 213-354-2005

Plasma and magnetic field data from ISEE 3 are used to

study Tangential Discontinuities (TD's) in the solar wind. TD's are selected for study because they do not propagate through the wind and thus retain some information about conditions at the solar source. Emphasis is given to (1) understanding the frequency of occurrence and the nature of TD's from different sources of the solar wind, (2) examining TD's which mark changes of solar wind composition in an attempt to understand the origin of helium abundance variations, and (3) using plasma variations across large, isolated TD's to estimate effective transport coefficients. MHD discontinuities are identified during routine processing of the ISEE-3 magnetometer data (E. J. Smith, Principal Investigator). Additional MHD discontinuities with smaller magnetic signatures can be found by visual inspection of plots of high-time resolution plasma data processed at Los Alamos National Laboratory by the Principal Investigator for the solar wind experiment (S. J. Bame). In this work, high-time resolution magnetic field data are used to perform a minimum variance analysis to determine the principal axes of the discontinuity and the component of the magnetic field normal to it. Field and plasma data are then combined to determine whether or not a discontinuity is tangential. Statistical analyses are performed on the resulting set of TD's to search for and understand systematic associations with solar wind streams of different origins. Multivariable correlation analyses will be performed for the subset of TD's which exhibit changes of helium abundance, and time profiles before and after suitable TD's will be examined in detail to model the rates at which different diffusion processes tend to destroy the discontinuities.

W84-70573 **385-38-01**
Marshall Space Flight Center, Huntsville, Ala.
CORONAL DATA ANALYSIS
E. Hildner 205-453-0123

The objective is to understand coronal mass ejections, both in the solar corona and in interplanetary space. The objective is approached in the following four ways, using a SMM Coronagraph/ Polarimeter data, correlative data, and numerical modeling: (1) SMM and correlative data for individual mass ejection events are studied to understand thoroughly the event's creation and evolution and their relationship to other forms of solar activity; (2) a list of coronal transient's occurrence and properties are prepared to facilitate comparisons between and among transient events; (3) the behavior of idealized transients near the Sun are calculated through numerical modeling; and (4) coronal mass ejections in interplanetary space are examined, primarily observationally, and also by numerical modeling.

W84-70574 **385-41-01**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS: ASTRONOMY
Mead J. M. 301-344-8543
(188-41-51; 188-41-55)

This RTOP will develop tools and techniques to facilitate and improve the reduction, analysis and understanding of astronomical data, primarily through the application of computers for managing large blocks of bibliographical and observational information, including digitized images and spectra, obtained at all wavelengths for stars, galaxies and other extended objects. A series of monographs on the subject, Nonthermal Phenomena is Stellar Atmospheres will be produced. The current machine-readable data base will be expanded by: (1) searching the journal literature, particularly in the IR and UV, to obtain more complete data and bibliographical coverage; (2) combining catalogs of variable stars, cool stars and extended objects and (3) observing with IUE to contribute to knowledge of astrophysical plasmas; A computerized astronomical data retrieval system, with associated software will be developed in order to produce data searches, digital plots, and bibliographical information for specified catalog ID numbers, positions and other parameters at all wavelengths; An interactive astronomical data analysis facility will be operated to provide astronomers with the display, enhancement and analysis tools needed to interpret digitilized images and spectra; A series of astrophysics research volumes will be prepared by laying out the best space data and discussing critically the current theories for interpreting these data.

W84-70575 **385-46-01**
Goddard Space Flight Center, Greenbelt, Md.
HIGH ENERGY ASTROPHYSICS: DATA ANALYSIS, INTERPRETATION AND THEORETICAL STUDIES
Jonathan F. Ormes 301-344-8801

This RTOP is to support laboratory effects at processing, analysis and interpreting the data involving correlative studies from a variety of spaceflight experiments, and to conduct theoretical studies to support this effort. These theoretical and interpretive studies lead to the publication of results in the scientific literature and help in the planning of new missions in the areas of X-ray and gamma ray astronomies, energetic particle or cosmic ray astrophysics, and cosmological studies. The aproach involves use of multisatellite data sets such as Voyager, Pioneer, IMP and Helios data for cosmic ray studies and Ariel 5, OSO-8, HEAO-1 and Einstein for X-ray astronomy, and comparisons with data from other observatories, both space and ground based, at other wavelengths. A strong emphasis is placed on creating the theoretical framework for interpreting the results. This RTOP supports graduate student thesis research, research associates and occasionally a senior faculty member on leave from a academic institution. As an example, in the X-ray area we will follow-up on the discovery of net temporal and spectral phenomena in sources. The data bases span 5 years and offer complementary information on variability of sources on time scales of milliseconds to years and spectra from 0.5 keV up to 10 Mev. We plan to emphasize spectral-temporal correlations best studied with multiple observations, to study models recommended by recent theoretical work and observations at other wavelengths, and studies which could be followed up by future missions such as XTE.

Space Plasma Physics Data Analysis

W84-70576 **442-20-01**
Goddard Space Flight Center, Greenbelt, Md.
ATMOSPHERE-IONOSPHERE-MAGNETOSPHERE INTERACTIONS
R. E. Hartle 301-344-8234

The basic objective is to study the observed properties of the inner magnetosphere, ionosphere, mesosphere and thermosphere to identify and understand the physical and chemical processes operating in these regimes, emphasizing how they interact. This is achieved by processing, analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated, permitting the study of long-term phenomena, comparison of data with new theories and models, correlative studies of data obtained from various satellites and ground based observatories, and the deposition of additional data in the National Space Science Data Center. The essential data to be used in this investigation include electron densities and temperatures, ion and neutral composition, neutral winds, ion temperatures and drifts, electric fields, magnetic fields, electromagnetic radiation and energetic particles of magnetospheric and ionospheric origin. These data are used to determine the various interrelated chemical, compositional, dynamical and energetic states of the inner magnetosphere, ionosphere, thermosphere and mesosphere and the transport and deposition of mass, momentum and energy in and between these physical regions. These basic properties and processes are then used to analyze specific geophysical phenomena such as: electric field induced ion drifts in the ionosphere and inner magnetosphere, chemistry and dynamics of mid and high latitude troughs, auroral substorms, ionospheric storms, Joule heating, PCA events, tidal and gravity waves, depletion and filling of plasmasphere, ionospheric plasma resonances, equatorial "bubble" formation, SAR Arcs, ring current decay, etc.

W84-70577 **442-20-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO ANALYSIS OF INTERPLANETARY SCINTILLATIONS
R. Woo 213-354-3945

This RTOP provides scientific analysis and interpretation of radio data received from various deep space missions. The radio scattering measurements of the solar wind are conducted with the coherent, monochromatic and point-source signals received from deep space spacecraft. These studies, made possible by recently developed radio scintillation techniques, yield information on density fluctuations covering a wider range of scale sizes and heliocentric distances than have ever been possible before. Extensive solar wind velocity measurements are also made in the acceleration region of the solar wind. The spacecraft whose radio signals are used include Pioneer, Helios and Voyager. The scientific objectives are: (1) the measurement of the solar wind velocity near the sun, (2) the study of structure and evolution of coronal transients (including shock waves and corotating streams) close to the sun, and (3) the electron density spectrum in the scale size range of 10-106 one million kms.

W84-70578 **442-20-02**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS - SPACE PLASMA PHYSICS
J. K. Alexander 301-344-5461

The basic objective is to study the observed properties of the interplanetary medium and the magnetospheres of the earth and other planets and to identify and understand the physical processes operating within and between these regimes. This is achieved by processing, analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated, permitting long-term phenomenological studies, comparisons of data with new theories and models, correlative studies of data obtained from various satellites and ground-based observatories, and the deposition of additional data sets in the NSSDC. The essential data to be used in this investigation include measurements of magnetic fields, plasmas, energetic particles, plasma waves and radio radiation. These data are used to determine the various dynamical and energetic states of the interplanetary medium and the magnetosphere and to assess the transport and deposition of matter and energy within and between these physical regions. These basic properties and processes are then used in the study of specific geophysical phenomena such as interplanetary sectors and flows, energetic particle acceleration, auroral current systems, and magnetic fields and plasma in the plasma sheet and the magnetotail. Basic theory complementary to the data analysis effort is carried out in the areas of kinetic plasma physics and the motion of charged particles in electric and magnetic fields.

W84-70579 **442-20-04**
Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLES AND PLASMAS IN THE MAGNETOSPHERES OF JUPITER AND SATURN
A. W. Schardt 301-344-5705

The overall objective of this study is to gain an understanding of the sources, sinks and dynamics of charged particle (electrons, ions, and even charged dust grains) in the magnetospheres of Jupiter and Saturn. This work will apply plasma theory and the theory of charged particle motion to data taken by Pioneers 10 and 11, and by Voyagers 1 and 2. Included is a study of the effect of plasma stability on the gross structures in Saturn's rings, structures which have not been explained by purely gravitational forces on the ring material by Saturn and its moons. We have prior to now been successful in pointing out the possible role of electromagnetic forces combined with gravitational forces in producing some major changes in optical depth with radius observed by the Voyagers. We will extend this work to other such features in the rings and possibly to the Uranian rings and the Jovian ring.

W84-70580 **442-32-01**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED MAGNETOMETER
E. J. Smith 213-354-2248

The helium magnetometer is being developed for use on future space missions. Investigations in Earth orbit at low altitude, approaching the Sun or orbiting Mars or the outer planets will require accurate, sensitive measurements often in large ambient fields. Various modes of operation of the magnetometer to provide both scalar and vector field measurements are being evaluated and compared with the scientific requirements of the various missions.

W84-70581 **442-36-04**
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTION
A. Barnes 415-965-5506

The overall objective is to investigate the solar wind, its origin, termination, dynamics and turbulence, as well as its interaction with planetary obstacles. Theoretical studies will be conducted, aimed at understanding the large-scale dynamics of the solar wind, its acceleration and heating mechanisms, and waves and turbulence in the solar wind. These studies employ known theoretical techniques of plasma physics and magnetohydrodynamics, and also often require extensions of basic theoretical plasma physics. Theoretical developments will be related to spacecraft plasma and magnetic data, as well as indirect observations of the solar wind. Theoretical studies of possible relations between variations in solar output (radiation and/or charged particles and magnetic fields) and terrestrial weather and climate will be carried out. Theoretical studies of the solar wind-Venus interaction will be conducted.

W84-70582 **442-36-55**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLES AND PARTICLE/FIELD INTERACTIONS
Keith W. Ogilvie 301-344-5904

The object of this research is to increase the knowledge and understanding of non-thermal plasmas occurring in the interplanetary medium and magnetospheres of Earth and other planets. This requires continuous improvement of measurement techniques, concentrating on advanced concepts for plasma detectors, mass spectrometers, magnetometers and radio and plasma wave analyzers. Work is also under way to improve the theoretical description of plasma properties, and to improve techniques for the interpretation of the results of space plasma experiments, requiring corresponding improvements in numerical techniques and in methods of data display.

W84-70583 **442-36-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE AND PARTICLE/PHOTON INTERACTIONS (ATMOSPHERIC MAGNETOSPHERIC COUPLING)
James P. Heppner 301-344-8797

The objective is to develop experimental and theoretical approaches for investigating the processes which provide strong coupling between the neutral atmosphere, the collision dominated ionospheric plasma, and the collisionless magnetospheric plasma. Within the framework of this overall objective, specific subobjectives are identified in terms of having: (1) key significance; (2) goals which are attainable with limited resources; and (3) close ties to future projects and programs. Emphasis is placed on the primary forces, electric fields and neutral winds, and the associated transport and energization of particles. Related topics include: electric fields in the Earth-ionosphere cavity and their relation to weather processes; electric current systems and associated magnetic field disturbances; the generation of thermospheric winds and gravity waves; atmospheric chemical composition anomalies; the transformation of atmospheric ions to trapped radiation; auroral particle acceleration mechanisms; and plasma instabilities producing ionospheric irregularities. New instrumentation is being developed for observations of tracer chemicals and

for measurement of low energy particles. Properties of double probes in low density plasmas are being studied. Models for the diffusion of tracer particles are being developed for planning future chemical release experiments. The closure of magnetospheric electric fields within the Earth-ionosphere cavity is being studied in support of low and middle atmosphere electric field investigations.

W84-70584 **442-46-02**
Jet Propulsion Laboratory, Pasadena, Calif.
THEORETICAL SPACE PLASMA PHYSICS
B. E. Goldstein 213-354-7366

The objective is to advance understanding of space plasma physics and to provide continuing theoretical support for observational space plasma programs. Work is to be performed primarily in two areas: (1) magnetostatic equilibrium models of the force balance at the magnetopause for open and closed magnetospheres, and (2) study of flow properties of cometary interactions with the solar wind. The objective of the equilibrium study is to determine the relative importance of various processes that result in changes in the magnetospheric configuration during magnetospheric storms and substorms. The inward motion of the dayside magnetopause during substorms is caused by enhanced Birkeland currents or, alternatively, by an increase in the amount of open magnetic flux. The importance of these processes will be assessed. The objective of the solar wind-cometary interaction study is to determine the role of mass loading, ionization processes, instabilities, magnetic penetration, and disconnection vents in the interaction between a comet and the solar wind, and allow interpretation of data from future cometary missions. Other investigations that are ongoing or approaching completion are a study of wave normal directions of ELF chorus, studies of the observed properties of the solar wind at 1 AU as a function of solar origin, and preparation of a book on the interplanetary medium. The magnetostatic equilibrium model determines the magnetopause location including effects due to internal current systems (ring current, Birkeland current, etc.) and due to boundary conditions on the magnetopause. The cometary-solar wind interaction model will be implemented with a finite difference code using implicit integration because of the widely varying Mach number and scale sizes.

W84-70585 **442-46-05**
Jet Propulsion Laboratory, Pasadena, Calif.
JUPITER AND TERRESTRIAL MAGNETOSPHERE-IONOSPHERE INTERACTION
M. M. Litvak 213-354-7441

Calculations will be done on a pulsed-maser theory of Jupiter and terrestrial pulsed radio emission and a theory of the interaction of the radio source in the lower magnetosphere with the upper ionosphere. Nonthermal plasma wave and particle distributions will be derived from the theory when predicted and observed burst waveforms and dynamic spectra are compared. Derived fluxes will predict auroral image and spectral data. The pulsed theory is based on concepts of maser amplifiers that radiate from localized hot spot regions that saturate at intensity levels set by the pump rate and that pulse because of competition with other stimulated effects. The radio intensity of finite pulse trains will be calculated from the rate equations predicting relaxation oscillations of the maser, the generation of soliton - like pulses due to nonlinearities, and the frequency drifting in time that accompanies these nonlinearities (such as stimulated scatter from the electrons). These intensities and frequency characteristics will be compared with those derived from observational data. Rate equations will be solved for the particle distributions so that the fluxes in the radio source will be obtained when the parameters of the pulsed-maser model are evaluated through comparison with radio data. Effects related to the energetics, the ion and neutral chemistry, and the fluid dynamics of the region below that of radio emission will be evaluated by means of available excitation cross sections for the particle interactions and related transport coefficients.

Technical Consultation and Support Studies

W84-70586 **643-10-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECTRUM AND ORBIT UTILIZATION STUDIES
J. Talbott 213-354-3768
(643-10-02)

The objective of this RTOP is to ensure the growth of space applications by providing the technical basis, legal authority and regulatory framework needed to obtain sufficient spectrum and orbits to meet current and projected requirements. The result of this work will be used by NASA to help determine its radio frequency and orbital requirements and to secure compatibility between NASA flight programs and other space and terrestrial services. The result will also be used by NASA and other government agencies for the purpose of supporting CCIR and World and Regional Administrative Radio Conferences; in making decisions on frequency and orbit utilization and assignments, earth-stations and satellite approvals; and in providing for the growth of existing and new multipurpose satellite services. The specific objective for FY-84 is to support NASA Headquarters with the analysis of spectrum and orbits issues to develop the domestic and international regulatory framework best to serve the national requirement for fixed and mobile communications and new multipurpose satellite services. The approaches are to participate in studies and analysis leading to advanced planning of the frequency allocation and regulatory framework for space services as well as studies for NASA, CCIR, and Administrative Radio Conferences. The studies for specific space programs will include: RFI analysis, transborder frequency sharing, feeder link frequency sharing, feeder link frequency assessment, and regulatory support. The economic/institutional study on the future satellite services will be continued. Studies on the fixed, mobile, broadcasting and new multipurpose satellite services will be conducted as required.

W84-70587 **643-10-01**
Lewis Research Center, Cleveland, Ohio.
SPECTRUM AND ORBIT UTILIZATION STUDIES
E. F. Miller 216-433-4000

The objectives are to: provide technical consultation services support in the area of space services with particular emphasis on preparing for international meetings related to the fixed-satellite service (FSS), the mobile-satellite service (MSS) and the broadcast-satellite service (BSS); provide the technical basis and regulatory support needed to obtain sufficient orbit/spectrum to meet current and projected requirements of NASA and the United States; Perform studies, develop analytical methods for planning, conduct evaluations, identify technology status and needs, perform critical technology developments, perform measurements (where necessary) to determine sharing criteria, and evaluate alternatives that result in efficient and cost-effective use of the geostationary orbit/spectrum resource. Specifically, these activities will: (1) support domestic and international preparations for the 1985/1987 Space Service WARC with emphasis on the FSS and the BSS; and (2) support domestic and international MSS planning in the 806 to 890 MHz band. The approach will be to conduct the described activities within the framework and schedules of the applicable CCIR Study Groups, the special preparatory committees established in the United States, and the national and international meetings called to support preparations for the conferences. Efforts planned are a combination of in-house and contract activities.

W84-70588 **643-10-02**
Jet Propulsion Laboratory, Pasadena, Calif.
NEW APPLICATIONS CONCEPTS, STUDIES, AND FILINGS
Gary K. Noreen 213-354-3484
(650-60-15; 506-58-25; 643-10-01; 643-10-03)

The objectives of this RTOP are to provide for the growth of existing satellite services and new communications satellite applications, and ensure compatibility of NASA's communications

flight programs with other space and terrestrial services. Government procedures require all agencies to submit proposed new space system concepts to IRAC and OMB for review four to six years prior to their planned date of initial operation. This is to ensure spectrum availability for telecommunications systems prior to commitment of public funds. In order to fulfill this requirement, this RTOP will include studies of system concepts with potential applications within the NASA Communications Program. These studies will include conceptual designs, user functional requirements, technical requirements, system descriptions, frequency and bandwidth requirements, cost effectiveness, system tradeoffs, and sharing studies required to demonstrate compatibility with existing or planned services. Specific objectives of this RTOP in FY 84 will be to develop designs of future LMSS spacecraft and to evaluate possible cooperative arrangements between NASA and the private sector in the United States to develop LMSS.

W84-70589 **643-10-02**
Lewis Research Center, Cleveland, Ohio.
NEW APPLICATION STUDIES
J. R. Ramler 216-433-4000
(643-10-01)

The objectives of this RTOP are: (1) identify and define new applications for communication satellites; (2) define preliminary concepts, configurations, requirements and costs of alternative operational systems for new applications; (3) identify the technologies required to enable the implementation of advanced operational communication satellites; and (4) formulate preliminary plans for developing the required technologies. The approach is to formulate and carry out in-house and contracted studies to meet the objectives. These studies will be of a scoping nature and will address the technical, economic and institutional/regulatory feasibility of operational systems.

W84-70590 **643-10-03**
Jet Propulsion Laboratory, Pasadena, Calif.
PROPAGATION STUDIES AND MEASUREMENTS
E. K. Smith 213-354-8040
(643-10-01; 643-10-02)

Radio wave propagation constraints in the earth space environment must be understood and accounted for in the design and specification of space communications systems. The Propagation Studies and Measurements program provides the focal point for national activities which support NASA's applications programs, development of prediction models, frequency allocation recommendations, orbit and spectrum use decisions, system specification and performance criteria related to space communications. The objectives of the NASA Propagation Studies and Measurements Program are to provide an understanding and analysis of the basic propagation mechanisms which hinder reliable earth space communications, and to develop predictive models for the quantitative evaluation of propagation effects in the bands allocated for space applications. The objectives of the program are accomplished under four major task activities: (1) propagation effects and experiments, (2) propagation modeling and analysis, (3) propagation assessment and evaluation, and (4) advanced propagation studies. The first area is structured to provide the data base, from satellite based experiments and ground based techniques for the development and validation of prediction models and system performance. The second area supports model development in site diversity, gain degradation, absorption, scintillation effects and studies of cloud attenuation, noise, and fade rate and fade duration. The third area involves support of NASA activities in the CCIR (International Radio Consultative Committee), the preparation and updating of the NASA Propagation Handbook Design for frequencies below 10 GHz, and propagation effects assessment at UHF for mobile satellite applications. The fourth area includes multiple scattering in rain at 30 GHz, ice depolarization degradation, and propagation constraints on digital and wideband systems.

Experiment Coordination and Operations Support

W84-70591 **646-41-01**
Lewis Research Center, Cleveland, Ohio.
EXPERIMENT COORDINATION AND MISSION SUPPORT
J. W. Bagwell 216-433-6196

The objective of this effort is to provide the technology, skills, and services necessary for the conduction of a meaningful experiment program using advanced communications satellites. The approach is to: (1) investigate and evaluate transitional and low cost techniques for providing earth terminal systems for the conduction of experiments using satellites incorporating advanced communications technologies; (2) supply equipment updates and operational in-house support of the communications research facilities at LeRC.

W84-70592 **646-41-02**
Ames Research Center, Moffett Field, Calif.
APPLICATIONS EXPERIMENTS PROGRAM SUPPORT
B. P. Gibbs 415-965-5001

The objectives of this RTOP are to: (1) coordinate with other Federal agencies and public sector organizations in the development of experimental satellite communications activities for emergency/disaster communication and public service applications; (2) assist users in the transition from the NASA experimental satellites to commercial satellites where continuity of service can be assured; (3) demonstrate Application Technology Satellite (ATS) technology and its applications for other governmental agencies and the public service sector; and (4) develop new techniques and applicable hardware for use with ATS. To meet our objectives in the development and transfer of satellite communication technologies, our approach will be to conduct satellite demonstrations and experiments using the ATS satellite and engage in direct interaction with potential and ongoing users of the spacecraft. This interaction will identify users' needs requiring the development of new technologies.

W84-70593 **646-41-03**
Ames Research Center, Moffett Field, Calif.
THIN ROUTE USER TERMINAL REQUIREMENTS AND EVALUATION
H. W. Jones 415-965-6616
(646-41-02)

This RTOP has two major objectives: to define and construct several prototype low cost ground stations for use with the INTELSAT and TDRS Advanced WESTAR satellites, and to conduct research and development on advanced thin route terminal concepts and designs. The first step in the approach is to define ground station specifications, using INTELSAT and Advanced WESTAR parameters. Then the ground station subsystems will be procured, tested and integrated. Operational tests and demonstrations will be followed by field experiments.

Advanced Communications Research

W84-70594 **650-60-15**
Jet Propulsion Laboratory, Pasadena, Calif.
MOBILE SATELLITE EXPERIMENT (CANADIAN COOPERATIVE)
F. Naderi 213-354-6288
(643-10-01; 643-10-02; 643-10-03)

A Land Mobile Satellite System (LMSS) consists of the space segment (i.e., the satellite), the ground segment, and the interconnective network which with its associated protocol and architecture defines and governs the network access and its interconnectivity. For the past few years NASA and JPL have been studying land mobile satellite systems with emphasis on the space segment (RTOP 643-10-02). However, the objective of this RTOP, which was initiated in FY 83, is to concentrate on the ground segment

and the networking aspects. In particular the overall objective of this RTOP is to define the ground segment (i.e., the mobile and base station equipment), and the networking technology, for the first generation mobile communications satellite and the NASA Mobile Satellite Experiment (MSAT-X) Program. In FY 83 and FY 84 this RTOP will: (1) delineate and evaluate networking options and associated ground segment hardware requirements, and (2) initiate the development of the ground segment equipment through breadboarding. Candidate services for LMSS are: (1) mobile radio telephone, (2) radio dispatch, (3) paging, (4) two way alphanumeric message service, (5) mobile vehicle position location and (6) low rate data transmission. As a part of this RTOP and through interfaces with potential users and system operators these services will be prioritized with respect to their perceived benefit to those groups who are the most likely users of the LMSS. Various technical approaches in implementing the desired services will be delineated. These will include analog and digital methods of modulation and various multiple access techniques as well as various concepts for low and moderate gain mobile antennas. The most efficient and cost effective approaches will then be selected for further development which will include breadboarding. These developmental activities of mobile terminals, mobile antennas, and base station equipment will be initiated early in FY 84 and will continue into FY 85.

W84-70595 **650-60-20**
Lewis Research Center, Cleveland, Ohio.
SPACE COMMUNICATIONS SYSTEMS ANTENNA TECHNOLOGY
J. W. Bagwell 216-433-6196

The objective is to conduct SR&T development on multibeam antenna systems for advanced geostationary communication satellites and supporting earth terminals. Efforts will be directed at applications of such antennas for multiple spot beams and scanning beams. Current efforts under this RTOP will: (1) develop proof-of-concept hardware of flight systems directed at the experimental verification of multibeam technology in 1988; and (2) develop and evaluate designs for advanced communications equipment for multiple channel earth stations. Two technology contracts are being pursued during the FY-80 to 83 time frame to accomplish the near term flight objective. A single technology contract is being pursued during the FY-82 to 84 time frame to accomplish the earth station near term objective. Future efforts will be directed at using advanced technology in the development of mobile antennas for 30/20 GHz applications and the development of spaceborne antennas for intersatellite links.

W84-70596 **650-60-21**
Lewis Research Center, Cleveland, Ohio.
SATELLITE SWITCHING AND PROCESSING SYSTEMS
J. W. Bagwell 216-433-6196
(650-60-22; 650-60-23)

The objectives are: to develop the switching technology for the routing of signals (message traffic) aboard multibeam, multichannel communications satellites; to develop spectrally efficient, high data rate digital modulation technology. Currently work is proceeding under this RTOP via contract for the design and development of a baseband processing (i.e., digital routing) proof-of-concept system for communications satellite applications, included in which is the development of the enabling LSI technology for system implementation. Future work will consist of contracts in FY-85 to develop advanced modulation technology and modems for the space and ground segments using advanced concepts and cost reducing techniques.

W84-70597 **650-60-22**
Lewis Research Center, Cleveland, Ohio.
RF COMPONENTS FOR SATELLITE COMMUNICATIONS SYSTEMS
J. W. Bagwell 216-433-6196

The objective is to perform supporting research and technology development in the area of space related RF components including power amplifiers (tube and solid state), low noise receivers, and other components. Initial efforts center on those components identified as needed in the 30/20 GHz band for Advanced Communications Technology Satellites (ACTS). Future efforts will focus on futher improving TWT performance in areas such as diamond support rods, linearization techniques, and tunneladder construction. Also, beginning in FY-85 POC amplifiers will be developed for intersatellite link and Ka-band mobile applications. A second objective is to determine the ranges of applicability of various component design configurations as functions of performance requirements and physical characteristics, e.g., volume, weight, power. By means of principally a contractual program, develop analysis and synthesis techniques for the above space program components; apply the developed techniques to determine the basic characteristics of components meeting specified requirements; fabricate experimental components; and test and evaluate fabricated components.

W84-70598 **650-60-23**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS LABORATORY FOR TRANSPONDER DEVELOPMENT AND SATELLITE NEWWORK EVALUATION
J. W. Bagwell 216-433-6196
(650-60-20; 650-60-21; 650-60-22)

The objectives are to design and develop a laboratory test facility to be used to test communication system components and subsystems, to provide laboratory simulations of satellite communications systems, and to further develop prototype ground terminal systems for use with advanced communication satellites. The approach will be to design, develop, and test 30 GHz uplink, frequency translator and 20 GHz downlink communications system, including transmitting and receiving ground terminals, and satellite segment. Continuous bit stream rates of nominally 50 MBPS and 500 MBPS will be used to modulate the links. End-to-end calculations will be made. Software simulation results will be compared with the hardware simulation results. Upon completion, network control methods will be added and bursty data transmissions will be tested and evaluated in both hardware and software. Finally, the baseband processor and several simulated stations will be tested.

W84-70599 **650-60-26**
Goddard Space Flight Center, Greenbelt, Md.
LASER INTERSATELLITE COMMUNICATIONS PROOF-OF-CONCEPT (POC) DEV.
Louis O. Caudill 301-344-5608
(506-61-46)

The objective of this RTOP program is to develop a proof-of-concept (POC) model of a laser intersatellite link (LISL) communications system. This POC model will undergo extensive testing and will provide the system level performance data needed to establish the technology readiness of high data rate space laser communication systems. Our approach to carrying out this program will be to generate a preliminary system design based on communication requirements provided by NASA Headquarters. Technology representing the current state of the art will be evaluated and incorporated into the design. Key technologies to be addressed in the POC program are: (1) high data rate laser transmitter; (2) light weight optics and structure; and (3) signaling and detection. The results of these technology programs will be incorporated into a complete communication terminal for final proof-of-concept verification. The communication links of primary emphasis are geosynchronous cross links, and low Earth orbiter to geosynchronous up links. The output of this program will provide the necessary technology and design data base to support the development of a flight qualified laser intersatellite link communication system for the 1990 time frame.

W84-70600 **650-60-26**
Lewis Research Center, Cleveland, Ohio.
ADVANCED STUDIES
J. R. Ramler 216-433-4000
(906-90-03; 643-10-20; 650-60-20; 650-60-21; 650-60-23; 643-10-02)

The objectives are to: (1) define the nation's current and future satellite telecommunications needs; (2) define advanced operational satellite system concepts and configurations to meet those needs while improving satellite capacity and frequency/orbit utilization; (3) define enabling technologies for such systems appropriate for advanced development by NASA; and (4) define and develop advocacy for suitable advanced communications technology development programs to be undertaken by NASA. The approach is to conduct in-house and contracted studies to assess market needs; determine system requirements; and define future satellite services and systems (both space and ground segments) requiring advanced communications technology. The output from these market, operational and experimental system requirement studies will be used to plan and guide future communications technology development.

Data Systems

W84-70601 **656-11-01**
Jet Propulsion Laboratory, Pasadena, Calif.
NASA GLOBAL RESOURCES INFORMATION SYSTEM (GRIS)
J. Urena 213-354-3032
(656-80-01; 656-13-40; 656-13-50)

The NASA Global Resources Information System (GRIS) program will provide world wide access to global data sets derived principally from NASA earthwatching satellites, but also from ancillary conventional data from worldwide sources. This distributed interactive system will provide facilities for researchers in earth, atmospheric, climatic, and oceanographic sciences to access and process multiple geographically dispersed data sets to derive global resource information. GRIS will be developed initially as a research tool for NASA researchers, based on an aggregation of pilot systems, and expanded through coordinated planning with other US agencies and international scientific institutions to enable resources research and planning on a global scale. The initial activities include coordinated planning and concept development between the earth resource and computer science disciplines to identify specific resource data sets to be utilized, and requirements for technology applications and evaluations. Coordination with other agencies, on-going NASA Programs and particularly, in-depth coordination with appropriate science discipline user groups in the definition of the program will be essential. The basic computer science technologies required for distributed data integration, data processing and data base management, global networking, data integration, data processing and data presentation will be identified and developed where required.

W84-70602 **656-11-01**
Ames Research Center, Moffett Field, Calif.
GLOBAL RESOURCES INFORMATION SYSTEM GLOBAL RESOURCES DATA BASE
Donald E. Wilson 415-965-6031
(656-13-40; 656-30-01; 656-13-50)

The proposed research is intended to establish the framework for a global resources information system to permit research investigating the interrelationships among the terrestrial, oceanic and atmospheric components of the resources in the environment. It will assist in defining and establishing standards for the Pilot-Ocean, -Climate, and -Land Resources Systems. User community data requirements will be surveyed and defined. Potential users will be identified and an inventory of computer capability performed. An experiment to investigate research issues through construction of sample data sets will be carried out. Participation of both a science definition team and a computer science steering group will be used to evaluate and establish system design criteria.

W84-70603 **656-13-40**
Jet Propulsion Laboratory, Pasadena, Calif.
PILOT OCEAN DATA SYSTEM
J. C. Klose 213-354-5036
(161-50-05)

The objectives of this activity are to: develop, through user interaction, an in-depth understanding of the user requirements for archiving, processing, display, and distribution of remotely sensed and supporting conventional oceanic data sets; evaluate, design, and implement the appropriate computer technologies, standards, and applicable products for a pilot oceanic information system; and provide dedicated computer systems on which to develop and demonstrate new capabilities which support the information processing needs of NASA's oceanic research community. These objectives will be pursued through the design, development, and operation of a Pilot Ocean Data System (PODS). This system, implemented on a dedicated VAX computer network, provides researchers in the oceanographic community with interactive access to selected satellite and conventional data sets. The PODS is being developed in multiple steps. The principal reason for a multistep implementation is to make maximum use of feedback from the science community. The user group participating in this project has an integral role in the system development and evaluation. The initial users are being drawn primarily from several institutions having a particular interest in satellite oceanography: Scripps Institution of Oceanography (SIO), Woods Hole Oceanographic Institution (WHOI), Massachusetts Institute of Technology (MIT), Florida State University (FSU), Oregon State University (OSU), Naval Post Graduate School (NPS), University of Miami, University of Washington, and JPL.

W84-70604 **656-13-50**
Ames Research Center, Moffett Field, Calif.
LAND RESOURCES PILOT PLANNING
S. D. Norman 415-965-5912
(656-13-40; 656-11-01; 656-30-01)

The objectives of this RTOP are to: (1) formulate a plan for developing a Land Resources Pilot data base; (2) develop a proof-of-concept system for distribution archiving and processing of land resources data (3) conduct preimplementation planning for a Land Resources Pilot program; and (4) assist in the establishment of a Land Resources Pilot Science Definition Team from members of the Land Resources science discipline community. A science definition team will be established by working through NASA Headquarters discipline offices in conjunction with JPL and GSFC. This team will function as an advisory panel to identify candidate data sets for use in the pilot program. The team will also identify research issues and assist in establishing and evaluating design criteria for the pilot system. Candidate system configurations including hardware and software capabilities will be proposed and evaluated as well.

W84-70605 **656-20-01**
Goddard Space Flight Center, Greenbelt, Md.
CYBER SOFTWARE TECHNIQUES
P. Schneck 301-344-9690

This RTOP seeks to provide users and potential users of the CDC Cyber 205 computer with an operational tool which will allow them to take advantage of the system's architectural features (employing long vectors in a pipelined mode of computation) and convert programs written in FORTRAN for conventional computers. An existing R & D tool will be extended and made operational, producing code for Cyber 205 use.

W84-70606 **656-20-26**
Goddard Space Flight Center, Greenbelt, Md.
MPP - APPLICATIONS DEVELOPMENT
P. B. Schneck 301-344-9690
(506-54-56)

The research and development under the purposes of this RTOP are to: develop the capabilities of the MPP to solve computationally intensive applications problems, and to develop tools for users to develop parallel algorithms (consistent with vector

approach on Cyber 205). The proposed work will develop a library, on the MPP, of commonly used image processing algorithms, as well as an operational preprocessor tool for converting standard FORTRAN programs to use the MPP.

W84-70607 **656-31-05**
Goddard Space Flight Center, Greenbelt, Md.
PILOT CLIMATE DATA SYSTEM
Paul H. Smith 301-344-5876

The Pilot Climate Data Base Management System (PCDBMS) was first implemented in FY-82. In FY-83, data manipulation utilities and a graphic subsystem were added to the catalog and data inventory subsystems, and direct support for scientific researchers was started. The demonstration system phase for the PCDBMS was successfully completed during FY-83. During FY-84, this RTOP plans to expand the support within the Applications Directorate of GSFC, and to develop new capabilities to meet the needs of these users. To achieve these objectives, the PCDBMS will continue to operate and maintain its computer facility, and provide support for data operations and software maintenance. To support the added users, the PCDBMS will also need to increase the available disk storage space. Beginning the FY-83 the name is shortened to Pilot Climate Data System. This Pilot Climate Data System will be the lead system and central data base facility for the Global Habitability Program.

W84-70608 **656-42-01**
Goddard Space Flight Center, Greenbelt, Md.
SCIENCE AND APPLICATIONS COMPUTING CENTER (SACC) UPGRADE
Fred B. Shaffer 301-344-8580
(656-50-02)

The SACC is responsible for providing purpose computational support for NASA-sponsored scientific research, along with coordinating central facility activities with distributed components to improve the overall quality of computational support to scientists. The objective of this RTOP is to upgrade the central computer facility to enhance functional capabilities to better support an on-line, interactive environment for scientists and engineers to analyze data. The overall strategy is to continue to evolve the facility into the future so as to meet new and changing requirements in an incremental fashion and to take advantage of rapid advances in computer technology as they are available and appropriate. The upgrade project began in FY-82 when an IBM 3081 processor and supporting peripherals were installed to replace an obsolete IBM 360 system. Current plans call for subsequent phases to include a mass storage device, a printer subsystem, and enhancements to the central processor. The SACC facility is a key element of the insitutional base to support the NASA science mission and provides the core capability upon which other data system enhancements will be developed (e.g., networking to share databases, improved graphics tools, on-line NSSDC catalogue, etc.)

W84-70609 **656-44-10**
Goddard Space Flight Center, Greenbelt, Md.
TRANSPORTABLE APPLICATIONS EXECUTIVE
D. Helfer 301-344-9425
(656-85-01; 175-29-56)

This effort proposes to continue development of a software executive under which new interactive applications data systems may be implemented in an efficient and cost-effective manner, and which features (1) a powerful and usable interactive interface for users; (2) the ability to transport multi-source and multi-discipline data and applications software between systems; (3) distributed remote processing within a network of computers; and (4) device-independent imaging and graphics software. Under this RTOP, the concepts and software necessary to support a transportable interactive analysis base and techniques for distributed processing with integral catalog management, executive control, communications, and image and graphics processing will be developed, evaluated and demonstrated. This RTOP supports the following major NASA programs: the Severe Storms Research Program, the VAS Demonstration Project, the LANDSAT-D Assessment System, the Networking RTOP, the Atmospheres Pilot, the Pilot Climate Data System, all at GSFC: and the JPL Multimission Image Processing Lab.

W84-70610 **656-50-01**
Goddard Space Flight Center, Greenbelt, Md.
ON-LINE DATA CATALOG
Joseph H. King 301-344-7688

This RTOP will design and implement a remotely accessible on-line data catalog which will describe the availability and selected other characteristics of data sets available to the space science community. The approach is: (1) identify functional requirements for an initial system via interaction with intended user community: data sets to be identified and level of detail about each; level of user query capability and user interface friendliness; estimated volume of activity and response time requirements; etc.; (2) estimate requirements and scope of full system; and (3) investigate available DMS packages; identify any needed communications hardware or software; procure any needed hardware or software; upgrade contents of NSSDC information files as appropriate.

W84-70611 **656-60-10**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED TECHNOLOGY: IMAGE DIGITATION
D. A. Klinglesmith 301-344-6541

This RTOP is concerned with the development of a high speed digital microdensitometer for use with astronomical imagery. The major need for the new microdensitometer results from the increased requirements in photometric precision and overall system throughput. The standard astronomical microdensitometer currently in use around the world is capable of digitization at a rate of a few thousand samples per second at low photographic density and only a few hundred samples per second at high densities (above 3.0D). The current photometric precision is in the range of 0.01D. Our approach will be twofold. First, an effort will be directed at extending the currently accepted machine to its limits. This will be done by replacing existing electronics with modern modules and thereby gain at least a factor of 5 to 10 in speed without any significant decrease in photometric response. Second, an effort will be directed at determining the specifications for the next generation high speed astronomical densitometry. This will be done by defining the astronomical requirements in terms of image material, photometric precision, system throughput, digital data storage and long term stability.

W84-70612 **656-62-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SYNTHETIC APERTURE RADAR DATA SYSTEM RESEARCH AND DEVELOPMENT
Wu Chialin 213-354-2061
(656-80-01; 656-11-01; 656-13-50; 656-13-40)

The overall objective of this RTOP is to develop, evaluate and demonstrate end-to-end data system concepts and data processing techniques to facilitate and automate transmission, processing, storage, and analysis of data gathered by future spaceborne and airborne SAR sensors. The near-term emphasis is on the SIR-B mission. Data system research development for other OSSA SAR missions including CV-990, Venus Mapper, SIR-C is also part of the objective of this RTOP. The specific tasks proposed in this RTOP include the development of SAR correlation S/W for special SIR-B radar modes, operational SAR rectification and mosaicking software, CV-990 SAR on-board digital processor, data and information distribution network, etc. The approach is to conduct end-to-end data system development planning and develop a number of selected subsystem elements by innovative use of commercially available equipment.

W84-70613 **656-80-01**
Jet Propulsion Laboratory, Pasadena, Calif.
PILOT PLANETARY DATA SYSTEM
A. L. Lane 213-354-2527
(656-19-40; 656-19-50; 656-11-01)

The objectives of this RTOP are to: (1) develop a pilot data

system to support the data management and information extraction requirements of the planetary science programs; and (2) provide a test bed to develop and evaluate distributed data archive and processing standards and techniques. To meet these objectives, the approach will include: (1) implement a distributed data archive and processing system to catalog, manage, display, analyze and distribute planetary science data; (2) identify planetary data sets to include in the pilot system configuration; (3) develop data format standards and system interface protocol standards; (4) develop a user-friendly remote query system for on-line browsing of catalogs of data in distributed archive; and (5) develop common transportable processing software for use in distributed processing environment.

W84-70614 **656-85-01**
Goddard Space Flight Center, Greenbelt, Md.
LOCAL AREA COMPUTER NETWORK
William H. Mish 301-344-5444

The purpose of this RTOP is to permit flexible and easily distributed computing by tying together heterogeneous computers, peripherals, and terminals/workstations, both internal and external to GSFC. The long-term objective is to develop a Local Area Network (LAN) integrating scientific computers and terminals using a robust architecture that will permit easy future expansion. The underlying philosophy in carrying out this RTOP is, to the extent possible, to apply and integrate commercially available network offerings in accordance with the ISO/ANSI Reference Model for Open System Interconnection(OSI). This model provides a common architectural basis for coordinating the various standards required for OSI. Any local tailoring or specialized development will be limited to areas where there are no widely supported standard protocols and will be isolated within layers of the OSI model to allow for consistent interfaces, portability to different environments, and modular replacement when and if widely supported standard protocols do become available. The approach will be to implement a pilot network linking the Science and Applications Computing Center (SACC) IBM 3081 processor with a VAX 11/780 (Code 690) and a PDP 11/44 (Code 680). In parallel with this, selected terminals will be linked to the SACC 3081 processor at speeds up to 19.2 kbps via the in-place CATV network, providing a testbed to evaluate use of broadband communications technology in our environment. The network will then be expanded to include other computer facilities within the Sciences and Applications Directorates, along with gateways to remote sites.

W84-70615 **656-85-02**
Goddard Space Flight Center, Greenbelt, Md.
GRAPHICS TECHNOLOGY
Edward C. Sullivan 301-344-8808

A general purpose scientist friendly system for graphics display will be designed and implemented. The system will be transportable over a wide class of computers and usable with many graphics devices. The system will satisfy all the general purpose graphics requirements for the Science and Applications Computer Center's user community. After user requirements have been determined, the system will be designed to provide an interface where users can define the graphical output in fairly general easily specified terms, rather than a string of arguments to a routine that requires lengthy consultation with reference manuals. In conjunction with the system implementation, Goddard Space Flight Center specific numerical routines and data bases will be identified and added to the system so that they may be referenced automatically.

User Liaison and Technology Demonstration

W84-70616 **663-80-03**
National Space Technology Labs., Bay Saint Louis, Miss.
GULF COASTAL PLAIN TEST AREA
Patricia K. Conner 601-688-2042

The objective of this RTOP is to test and evaluate experimental remote sensing technology for application to terrestrial resource mapping, monitoring and modeling requirements intrinsic to the Gulf Coastal Plain. This is a continuing RTOP for which a permanent test area has been established for the purpose of quantifying sensor and technique performance against various information requirements. These requirements have been defined in the land surface inventory and monitoring section of the NASA Global Habitability Science Research Program plan draft and by the non-NASA user community. This RTOP contains three discrete tasks: (1) test and evaluation of multiresolution sensor data against selected classification schemes to determine capabilities for mapping and monitoring natural and human-induced Gulf Coastal Plain features; (2) test and evaluation of TM-derived land cover and weighted simulation modeling performance in terms of the preservation, conservation and utilization concept for assessing coastal land capability; and (3) test and evaluation of TM techniques for discriminating and mapping the areal extent of urban land use components.

Climate Research

W84-70617 **672-20-00**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE PROCESSES
O. W. Thiele 301-344-9006

The objectives are to extract information on climate and climate related parameters from satellite data, and develop techniques for remote sensing of climate parameters, including the development of methods for extracting cloud cover parameters from existing satellite images in support of the International Satellite Cloud Climatology Project. The approach will be to: (1) participate in field experiments and conduct theoretical studies to develop methods for remote sensing of cloud parameters; collect aircraft remote sensing data on a variety of cloud types to achieve a better understanding of the radiative properties of clouds; (2) develop algorithms for determining cloud cover amount, cloud height, and cloud type from multichannel satellite images; (3) utilize microwave data from Nimbus 7 SMMR to produce maps of sea surface temperature, atmospheric water vapor, atmospheric liquid water, and surface winds; conduct analyses of the data to determine their validity; explore potential use of the data to estimate energy and moisture exchange between the oceans and the atmosphere; Analyze Ocean Temperature Scanner (OTS) data collected during MASEX; and (4) examine the potential use of satellite altimetry data (SEASAT and GEOS-3) to study changes in the ice sheets that may affect climate.

W84-70618 **672-21-01**
Ames Research Center, Moffett Field, Calif.
CRYO GAS COLLECTION, CHROMATOGRAPHY AEROSOL PRECURSOR GASES
J. Vedder 415-965-6259
(672-21-02; 672-21-03; 672-21-04)

The primary objective of this research is to experimentally measure, and thus empirically determine, the distribution of sulfur-bearing trace gases in the Earth's upper atmosphere as a function of altitude, latitude, and season. The concentrations of these sulfur gases directly affect the rate of formation of sulfate aerosols and their resultant chemical and physical properties. Knowledge of the distribution of these precursor gases is of crucial importance to photochemical models of the stratosphere and to the global scale climatic assessments derived from the model predictions. Cryogenically enriched air samples will continue to be collected on the U-2 aircraft and returned to the laboratory for analysis by gas chromatography. Measurements of the pertinent sulfur gases, sulfur doxide, carbonyl sulfide, etc., will be made as part of the stratospheric volcanic effects missions. The gas data collected on these missions will be correlated with the aerosol and meteorlogical data sets also obtained as part of the mission. In addition, the sulfur gas distribution data will serve as input to the theoretical chemical-physical models of the stratosphere.

W84-70619 **672-21-02**
Ames Research Center, Moffett Field, Calif.
AEROSOL PROPERTIES AND PROCESSES THAT AFFECT CLIMATE
P. Russell 415-965-5404
(672-21-01; 672-21-03; 672-21-11)

The overall goal of this program is to advance understanding of aerosol properties and processes that affect climate. Specific aims are to: (1) improve confidence in aerosol measurements by comparing results of different techniques, explaining and resolving any discrepancies; and (2) understand the evolution of aerosol physical and chemical properties in perturbed and unperturbed conditions. Measurements are made with several different types of instruments on appropriate aircraft platforms. These measurements are often made as a part of coordinated missions planned and conducted with other experimenters and theoreticians. Data are analyzed and compared (including both Ames and outside results). Measurement and analysis techniques are developed and improved. Papers on instrumentation, analyses, and interpretations are published.

W84-70620 **672-21-03**
Ames Research Center, Moffett Field, Calif.
AIRCRAFT EXPERIMENT INTEGRATION AND SUPPORT
P. Russell 415-965-5404
(672-21-01; 672-21-02; 672-21-04)

The goals of this program are to: (1) ensure that experiments are successfully integrated onto appropriate aircraft in time to participate in scheduled missions and pre-mission test flights; (2) provide flight support; (3) provide auxiliary experiments as required to meet the science objectives of the mission. Aircraft space allocations are developed in conjunction with experimenters, advisory groups, and the integration contractor. Integration cost estimates are obtained from the aircraft integration contractor in consultation with the experimenter. Integration is funded and progress and completion are monitored. Laison between experimenters, integrators, and flight personnel is maintained before, during, and after flights.

W84-70621 **672-21-04**
Ames Research Center, Moffett Field, Calif.
RADIATION MEASUREMENTS
F. P. J. Valero 415-965-5510

The absorption of radiation in the atmosphere plays a fundamental role on weather and climate. This interaction of radiation with matter depends both on the presence of naturally occurring molecules and on anthropogenic pollution. The objectives of this work include the study, measurement and modeling of radiation - matter interaction in the Earth's atmosphere. Measurements are performed using aircraft as instrumental platforms. A variety of aircraft are available for these studies. From these measurements, the significant radiative energy parameters are determined and used in atmospheric modeling.

W84-70622 **672-21-11**
Ames Research Center, Moffett Field, Calif.
FILTER SAMPLES
A. Margozzi 415-965-5517
(672-21-02; 672-21-01; 672-21-03)

The overall goal of this program is to provide information which will enhance our understanding of the effect on climate of stratospheric aerosols (both background and volcanically augmented), stratospheric aerosol composition, burden and residence times, and mechanisms of aerosol formation. Stratospheric filter samples are collected aboard the U-2 and ER-2 aircraft, using the exiting multiple filter sampler. The samples collected are analyzed for sulfate and other aerosol trace constituents.

W84-70623 **672-22-03**
Jet Propulsion Laboratory, Pasadena, Calif.
CLOUD PROPERTIES FROM SATELLITE RADIANCES
J. P. Schieldge 213-354-2507

Techniques will be developed to discriminate between stratus-type (low level) and cirrus-type (high level) clouds. The main data set will comprise ten days of Advanced Very High Resolution Radiometer (AVHRR) radiance measurements from NOAA satellite flights. The data will cover the California coastal region during the stratus season, from April to October. Statistical Pattern Recognition (SPR) will be used to develop algorithms for the automatic classification of cloud type. The SPR algorithms will be tested against other cloud type discrimination methods in current use (e.g., spatial coherence, threshold). This research will support the NASA Climate Research Program's efforts in developing a global cloud climatology.

W84-70624 **672-30-00**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE MODELING
W. R. Bandeen 301-344-8406

The objectives are to develop climate modeling capabilities to guide the design of the observing system, to optimize the utilization of space-acquired data, to carry out physical processes studies, and to assess climate predictability. The approach will be to: (1) develop semi-empirical methods for understanding, detecting, and predicting climate change; (2) improve the GLAS GCM for use in seasonal cycle predictability studies; (3) develop efficient radiative transfer routines for use in climate models; (4) conduct studies of the sensitivity of climate to radiative forcing using the seasonal version of the GLAS Multi-Layer Energy Balance Model (MLEBM); (5) develop Planetary Boundary Layer (PBL) parameterization methods for global models; and (6) study blocking events to identify dynamical predictors.

W84-70625 **672-31-02**
Ames Research Center, Moffett Field, Calif.
AEROSOL FORMATION MODELS
O. B. Toon 415-965-5971
(672-32-01)

The objective is to simulate the ambient stratospheric aerosol layer and the El Chichon volcanic cloud. The simulations will be compared with observations, and will be used to create input data for climate models, to test data sets for internal consistency and to better determine the physics and chemistry of the stratosphere. A two-dimensional model of stratospheric aerosols has been developed and is reasonably successful in duplicating the observations. The major problem with two dimensional models is obtaining realistic transport. A multi-dimensional model will be used to replace the 2-D model. This will allow both 2-D and 3-D simulations. The 3-D simulations will be done using observed winds and winds from a dynamical model. Extensive data comparisons and sensitivity tests will be done with this multi-dimensional model.

W84-70626 **672-32-01**
Ames Research Center, Moffett Field, Calif.
CLIMATE MODELING WITH EMPHASIS ON AEROSOLS
J. B. Pollack 415-965-5530
(672-31-02)

A coordinated set of theoretical, laboratory, and field investigations of the chemistry and radiative properties of natural (e.g., volcanic) and man-made atmospheric aerosol particles are conducted in order to assess their impact on regional and global climate. The field investigations are intended to provide complementary information on aerosols that are being obtained from spacecraft platforms (e.g., SAM II and SME) so as to insure that a comprehensive set of aerosol properties are gathered for climate analyses. The theoretical and laboratory tasks are directed at interpreting and utilizing the aerosol data sets to perform the desired climate assessments. The centerpiece of the field investigations is a set of coordinated aerosol measurements, which are flown together on an appropriate aircraft platform (e.g., U-2 and 990). When possible, these flights are conducted in conjunction with spacecraft and other airborne aerosol measurements. Information is obtained on both the aerosol formation mechanisms and on their radiative properties so as to enable the development of a predictive capability as well as a determination of the present climatic effect of aerosols. Both theoretical modeling and labora-

tory studies are used to further define the mechanisms of aerosol information, to provide hypotheses that can be tested by the field investigations, and to provide ultimately the predictive tools. Theoretical investigations involving radiative transfer, dynamics, and aerosol formation are utilized for making the climatic assessments.

W84-70627 **672-40-00**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE OBSERVATIONS
Otto W. Thiele 301-344-9006

The objectives of this RTOP are to: (1) study ways of using available satellite data to measure or infer climate parameters (e.g., ocean/air heat flux, sea surface temperature, soil moisture, etc.), (2) evaluate spaceborne techniques for precipitation measurements, (3) complete analysis of MASEX data on air-sea heat flues during cold air outbreaks, and (4) determine changes in solar size and relate to changes in solar luminosity which in turn relates to the total energy available to the Earth/atmosphere system. The approach will be to: (1) develop transfer functions to extract climate parameters from visible and infrared sensors on both low and geosynchronous earth orbiting satellite with emphasis on ocean/atmosphere boundary conditions for extending heat flux estimates from coastal regions to the open oceans; (2) investigate instrumentation and sampling options for important climate parameters such as global precipitation and ocean characteristics, e.g., aircraft equipped with dual wavelength radars and radiometers, and a shuttle-based mission utilizing real aperture radars; (3) analyze solar eclipse data and model relationship between radius and luminosity changes; and (4) make direct solar diameter measurements and model changes in size, shape and surface temperature to changes in total solar flux.

W84-70628 **672-40-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR IRRADIANCE ROCKET FLIGHTS
R. C. Willson 213-354-3529

The objectives of the solar irradiance rocket program are: (1) to maximize the long term precision of the total solar irradiance record being compiled by two satellite solar irradiance monitoring experiments, the Active Cavity Radiometer Irradiance Monitor I (ACRIM I) on the Solar Maximum (SMM) and the ERB/HF on NIMBUS 7, by conducting real time flight intercomparisons between their solar observations and those of three independent rocket solar irradiance experiments; (2) to provide the state-of-the-art in defining the absolute radiation scale at the total solar irradiance level; and (3) to relate the state-of-the-art in defining the absolute radiation scale at the total solar irradiance level. The approach will be to conduct the 5th in the series of rocket flights begun in 1976 using the payload developed for the 4th flight (flown in comparison with the Spacelab 1 Mission in 1983). The payload will be comprised of three experiments: the refurbished rocket equivalent of the NIMBUS 7-ERB/HF, the refurbished ACR402 (with ACR IV sensos eqivalent to those on the SMM/ACRIM I) and an instrument based on an independent sensor technology developed by the World Radiation Center at Davos, Switzerland - the PMO experiment. Preflight ground intercomparisons will be conducted between the rocket, reference and Spacelab 1 instruments at the Solar Testing Facility of JPL's Table Mountain Observatory.

W84-70629 **672-50-00**
Goddard Space Flight Center, Greenbelt, Md.
CLIMATE PROGRAM SUPPORT
Otto W. Thiele 301-344-9006

The objectives are to: (1) provide program support to NASA Headquarters and Goddard for a broad based NASA climate program which in turn involves a subtantial contribution to the National Climate Program and (2) provide resources for the Climate Program's share of HSVP computing support. The approach will be to: (1) develop recommendations for climate program initiatives in connection with NASA, GSFC climate research; (2) provide planning support flow global satellite climate data base development, especially a global cloud climatology under the International Satellite Cloud Climatology Project (ISCCP); (3) provide representation to the Climate Information Sub-group of the National Climate Policy Board; (4) develop planning strategies for physical processes studies with particular emphasis on cloud and Earth/atmosphere radiation processes; (5) provide support for annual National Climate reports to Congress, annual science reviews, etc. ; (6) arrange for ad hoc science working groups, advisors panels, etc.; and (7) ascertain and coordinate both in and out of house climate program computing requirements and insure that resources are appropriately shared for hardware acquisition, operations and programming assistance.

Stratospheric Air Quality

W84-70630 **673-41-00**
Goddard Space Flight Center, Greenbelt, Md.
VARIABILITY AND TRENDS IN STRATOSPHERIC OZONE, THE MIDDLE ATMOSPHERE, AND UV SOLAR FLUX VARIATIONS
Donald F. Heath 301-344-6421

Activity will include: (1) the analysis, interpretation of atmospheric ozone, meteorological and UV solar flux data for the investigation and determination of sources and mechanisms responsible for the natural variability of the middle atmosphere; (2) investigation of possible secular changes in stratospheric ozone, determination of trends and identification of anthropogenic and solar related effects; (3) evaluation of the effects and changes in ozone and UV solar flux on the structure and dynamics of the middle atmosphere; (4) production of climatology of ozone, meteorological parameters such as height, temperature and wind; (5) investigation of SO2 distribution in the stratosphere (volcanic) and troposphere (industrial pollution); (6) modeling solar flux variability; (7) modeling of ozone transport and temperature dependent chemical reactions including radiative damping and photochemical acceleration; and (8) analysis of NIMBUS-7 TOMS data for dynamical and statistical properties of total ozone field. Through the use of harmonic and trend analysis techniques, long and short term variations of ozone are investigated on a global scale for possible mechanisms which determine the spatial and temporal variability of ozone. Variations in UV solar spectral irradiance are studied for information on mechanisms which can produce a variable ultraviolet solar flux input at the top of the atmosphere. Existing models of the solar atmosphere are used to study possible solar processes. Observed variations in ozone, UV solar flux, atmospheric temperature, winds are structure are evaluated for consistency through existing multi-dimensional atmospheric models at GSFC. Numerical models are used to simulate observed behavior of total ozone from TOMS including correlations with tropopause height, and wind data.

W84-70631 **673-41-12**
Jet Propulsion Laboratory, Pasadena, Calif.
STRATOSPHERIC CIRCULATION FROM REMOTELY SENSED TEMPERATURES
L. S. Elson 213-354-4223

The objective of the proposed research is to develop an improved quantitative understanding of the large scale circulation of the lower stratosphere in the 15 to 30 km region. This objective involves an evaluation of the improved vertical resolution, and the use winds deduced from limb observations of temperature, and the identification and quantification of dynamical processes that are either second order but significant or first order but not included in conventional empirical analyses. To carry out the objective of this task, limb observations of temperature will be used in two ways. First, temperatures, or geopotential fields directly derived from the temperatures will be analyzed for both traveling and stationary waves. Second, geopotential fields will be used in the diagnostic determination of the zonally averaged circulation, the wave circulation and the interaction between the two.

W84-70632 **673-41-13**
Jet Propulsion Laboratory, Pasadena, Calif.
SATELLITE DATA INTERPRETATION, N2O AND NO TRANSPORT
S. S. Prasad 213-354-6423

Satellite observations of minor and trace chemical species and of precipitating electrons and protons will be analyzed to elucidate chemistry and transport of nitrous and nitric oxide. Satellite measurements of minor and trace chemical species will be subjected to statistical and correlative analyses to identify important features in the latitudinal-vertical distributions of these species and their seasonal variations. Column contents will be used when the noisy raw data do not allow the determination of the vertical profiles, e.g., in the case of the measurements of mesospheric nitric oxide by the SBUV experiment on board NIMBUS-7. Observed characteristics will be compared with the predictions from theoretical considerations involving chemical sources and sinks and vertical and horizontal eddy diffusion and mean motion in the framework of a zonally averaged, Eulerian photochemical-transport model. From this comparison we expect to gain a better understanding of the chemistry and transport of nitrous and nitric oxide.

W84-70633 **673-56-00**
Goddard Space Flight Center, Greenbelt, Md.
NASA HIGH SPEED COMPUTING FACILITY
C. E. Bock 301-344-8221

The purpose of this RTOP is to provide support for the procurement, operations, system programming, and user support activities for the NASA High Speed Computing Facility (NHSCF). This RTOP is a consolidation of individual tasks from five Office of Space Science and Applications RTOP's. The NHSCF system was provided under a contract with Control Data Corporation NAS5-26646. The new system provides a very high-speed computational resource and related services to support mathematical modeling and other research activities in the applications and space sciences disciplines, including global weather, severe storms, climate, upper atmosphere, oceans, and geodynamics. Detailed plans for implementation and operation of the NHSCF in FY-84 are incorporated in the NASA High Speed Computing Facility Management Plan.

Geodynamics Research and Technology Development

W84-70634 **676-01-01**
Goddard Space Flight Center, Greenbelt, Md.
GEODYNAMICS PROGRAM SUPPORT
J. E. Welker 301-344-6753

The objectives of this RTOP are: (1) to provide technical and financial management support to AN's (university grants and private contracts) in the geodynamics discipline; and (2) to provide funding for computer time used for geodynamics research. The approach will be to initiate, monitor, and report on research activities conducted for sponsorship of the Geodynamics Applications Notice.

W84-70635 **676-10-10**
Jet Propulsion Laboratory, Pasadena, Calif.
REGIONAL CRUSTAL DYNAMICS
G. A. Lyzenga 213-354-2244

The objective of this research is to provide understanding of the processes and physical state which characterize the crust and upper lithosphere in tectonically active regions. Continuing work will address the problem of the propagation and accommodation of stress from recurrent earthquakes. An additional task seeks to extend analytic and finite element models to problems of multiple faulting as they apply to earthquakes and crustal deformation.

W84-70636 **676-10-10**
Goddard Space Flight Center, Greenbelt, Md.
REGIONAL CRUSTAL DEFORMATION MODELING
S. C. Cohen 301-344-7641

The objectives are the development of geophysical models of crustal deformation and stress in various tectonic settings and the improvement in the understanding and description of processes of strain accumulation and release in the earthquake cycle including preseismic, coseismic, postseismic and interseismic effects. Models are required for comprehending Earth motions and for planning and analyzing geodetic observations. This RTOP supports the Geodynamics and Crustal Dynamics Projects. These in turn support the following end objectives: (1) support of U.S. program in earthquake hazard reduction; (2) support national and international programs in geodynamics and lithospheric dynamics. This RTOP also provides funding for a NRC/NAS Resident Research Associate to conduct basic geodynamics research on polar motion. The approach will be to: continue the development of analytical and numerical models of the time-dependent deformation and stress associated with earthquakes on strike-slip and dip-slip faults; interpret and improve these models using ground and space-derived data as they become available; and determine Earth parameters such as asthenospheric viscosity, lithosphere thickness, fault slip geometry, and slip magnitude for various regions. Expected results include analytical and numerical descriptions of earthquake-cycle related crustal and sub-crustal displacements, tilts, strains, and stresses which will aid in interpreting geodetic measurements and in deriving information about the Earth's dynamic processes and structure on a regional scale. Also, the analysis of polar motion data using digital filter techniques will continue.

W84-70637 **676-30-05**
Jet Propulsion Laboratory, Pasadena, Calif.
LITHOSPHERIC STRUCTURE AND MECHANICS
R. S. Saunders 213-354-3815

The objective of this research is to provide understanding of the properties and structure of the lithosphere and to understand the interaction between the lithosphere and crustal tectonism. Numerical techniques will be used to construct quasi-three-dimensional models to study the effect of an elastoplastic-viscous lithosphere. Problems related to the variation of lithospheric properties with depth will be addressed by employing finite element techniques to model motions using the geometric and material property constraints at moving plate boundaries with periodic earthquakes.

W84-70638 **676-40-01**
Jet Propulsion Laboratory, Pasadena, Calif.
GRM GRAVITY STUDIES
W. L. Sjogren 213-354-4868

The objective of this effort is to develop a new data reduction technique for producing a high resolution gravity field from satellite-to-satellite Doppler data as currently proposed by the GRM mission. The work is done in collaboration with W.M. Kaula at UCLA. A primary benefit from this task will be a significant savings in computer costs and time, when the real GRM data are attacked.

W84-70639 **676-40-02**
Goddard Space Flight Center, Greenbelt, Md.
GEOPOTENTIAL FIELDS (MAGNETIC)
R. A. Langel 301-344-6565

The major objectives of this RTOP are to develop more accurate and reliable models of the Earth's main magnetic field and its temporal variation. The approach includes both collection of all suitable data types and of the development of new analytic techniques. New observatory and repeat data are continually being added to our data set as they become available. Planned extension of models to epochs prior to those already analyzed (1960) will require acquisition and quality verification of additional data. Marine and aeromagnetic data are not yet extensively used. These are easily acquired but are of uneven, and often unknown, quality and so require extensive reduction before utilization. New techniques are under development both for the representation of secular

variation and for the main field itself. These include utilization of periodic terms and/or partial fractions for secular variation and of spline functions for the main field.

W84-70640 **676-59-10**
Goddard Space Flight Center, Greenbelt, Md.
GEOPOTENTIAL RESEARCH MISSION (GRM) STUDIES
T. Keating 301-344-8613
(676-40-01)

The objectives are to conduct: (1) system studies of the Geopotential Research Mission (GRM) and prepare a Phase C/D proposal; (2) gravity simulation; (3) Geodyn Program conversion; (4) support of science working group; and (5) magnetic simulation. System studies will determine the complex relationship of the doppler tracking, the DISCOS, the propulsion, and the on-board computer controlled drag-free flight profile. Geodyn Program conversion to the Cyber 205 will continue. Gravity and magnetic simulations will be performed to illustrate mission capability. The science working group will analyze mission performance parameters versus science products.

W84-70641 **676-59-33**
Marshall Space Flight Center, Huntsville, Ala.
SUPERCONDUCTING GRAVITY GRADIOMETER
Eugene W. Urban 205-453-5132

The objective of this RTOP is to demonstrate the feasibility of a three-axis superconducting gravity gradiometer for space flight that is capable of measuring gravity gradients along three mutually perpendicular axes with a sensitivity of 0.01 EU or better. A single-axis unit will be completed and tested, and a three-axis engineering unit will be designed, fabricated, tested, and refurbished for a possible shuttle test flight.

W84-70642 **676-59-42**
Goddard Space Flight Center, Greenbelt, Md.
LASER RANGING DEVELOPMENT STUDY
J. J. Degnan 301-344-7714

The long term objective of this RTOP is to support research and development leading ultimately to automated millimeter accuracy Satellite Laser Ringing (SLR) systems in the next decade. The accuracy of present SLR systems is limited at the 5 mm to 10 mm level by uncertainties in the atmospheric refraction correction. These limitations can be overcome by the use of two color ranging systems, but the concept places picosecond timing demands on the range receiver. These accuracies are over an order of magnitude beyond the capabilities of conventional electronic Time Interval Units (TIU's). Therefore, a specific near term objective is the development of an Optical Time Interval Unit (OTIU) consisting of (1) an optical clock consisting of a compact modelocked laser phaselocked to a stable frequency standard; (2) a Fabry-Perot frequency multiplier; (3) an optical counter consisting of a photodiode detector and counting electronics for the coarse time interval measurement; (4) a streak camera based timing interpolator for fine resolution.

W84-70643 **676-59-45**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN SPREADING ZONES - FEASIBILITY STUDY
L. E. Young 213-354-5018
(676-59-30)

This RTOP is intended to perform a system analysis of the use of SERIES technology for determining the location of an ocean surface platform with respect to the GPS (Global Positioning System) reference frame. The development of a system for measuring the location of benchmarks on the ocean floor with respect to an acoustic transmitter on the surface is being performed under another Geodynamics Program RTOP, by F. N. Spiess of Scripps Institution of Oceanography. The combined objective of these two RTOPS is to precisely tie ocean floor benchmarks to an earth centered reference frame. SERIES is a GPS-based system being developed for high precision, cost effective geodetic measurements, under the NASA Geodynamics Program. Current proof-of-concept receivers have demonstrated baseline measurements with a precision of several cm. The next generation system is being developed for use in determining the orbit of the TOPEX satellite. Further improvements are expected to increase precision to the one cm level. If this level of performance can be maintained in a system used at sea, it will be adequate for obtaining an absolute position for the surface element(s) of an acoustic sea floor benchmark system. Certain developments in system design are required in order to use this technology for sea surface positioning. These include antenna design, tracking the GPS signals from a wave tossed platform, and determining the orientation of that platform.

W84-70644 **676-59-55**
Goddard Space Flight Center, Greenbelt, Md.
GRAVITY GRADIOMETER PROGRAM DEVELOPMENT
W. D. Kahn 301-344-5462

The objective is to perform preparatory studies of a space-borne gravity gradiometer system for Earth and planetary mapping of the gravity field. Studies will be made to determine measurement precision, measurement rates, orbit requirements, and data reduction techniques, of a gravity gradiometer to map the fine structure of the Earth's gravity field.

Resource Observation Applied Research and Data Analysis

W84-70645 **677-21-24**
Goddard Space Flight Center, Greenbelt, Md.
RENEWABLE RESOURCES FIELD RESEARCH AND SPACECRAFT DATA ANALYSIS
Darrel L. Williams 301-344-8860

The overall objective is to develop and apply data interpretation techniques to the study of renewable resources problems. Particular emphasis is placed on techniques which utilize data from spaceborne instruments with spatial resolution capabilities which are either higher (i.e., Thematic Mapper) or lower (i.e., AVHRR, HCMM) than the standard Multispectral Scanner (MSS) resolution of 80 meters. Additional subobjectives include development of analytical techniques and instruments for ground truth measurements, the establishment of field measurement data sets, simulated data sets, and integration of data having variable spectral, spatial, and temporal resolution to address global science issues. Data sets consisting of existing geographical data, field measurements under controlled conditions and aircraft data are acquired and compared with space-based data as appropriate to assess land cover status, land use practices. The impact of various instrument parameters on determining land cover status, etc. are assessed. Algorithms for analyzing these data independently or in combination with one another are developed.

W84-70646 **677-21-25**
Jet Propulsion Laboratory, Pasadena, Calif.
VEGETATION AND URBAN LAND COVER MULTISENSOR ANALYSIS
B. N. Rock 213-354-6229
(677-42-08; 677-42-09)

The primary purpose of this task is to advance the state-of-the-art of resource management analysis and planning activities by developing techniques and software that integrate and interpret various remotely sensed data sets (visible, infrared--both reflected and emissive--and microwave) and collateral data to analyze land cover in both heavily vegetated and urban settings. The products of this research will help NASA focus on the essential parameter requirements for geometric and classification accuracy in future studies dealing with land use and vegetation assessment. Improvements in our capability to map and integrate remotely sensed data into land resources data bases are being pursued by: (1) developing procedures and software which integrate remotely sensed data with other collateral data into models that assess potential land capability under varying constraints to land use; (2) developing the analysis of research data sets of the Los Angeles

area composed of registered multi-frequency, multi-temporal and multi-sensor data sets; (3) continuing the analysis of SAR responses to land cover mapping by incorporating scatterometer measurements and modeling reflectance properties of Los Angeles area urban and near-urban land cover types; (4) determining the incremental improvement in both urban land cover and species/species association classification accuracy as achieved by using Thematic Mapper (TM) LANDSAT-4 imagery vs. M;ultispectral Scanner (MSS) imagery for selected urban sites and heavily vegetated (forested) sites.

W84-70647 **677-21-26**
Ames Research Center, Moffett Field, Calif.
THEMATIC MAPPER (SIMULATOR) STUDIES OF LAND RESOURCES IN WESTERN ECOZONES
R. C. Wrigley 415-965-6060
(677-21-25)

Objectives are to: (1) develop techniques for describing land resources in western U. S. ecozones using Thematic Mapper (TM) data, evaluate TM performance vs. the Multispectral Scanner (MSS) and utilize texture and advanced classifiers as means to incorporate spatial variability and spectral heterogeneity; and (2) to evaluate TM/TMS as one stage (along with MSS and photo/ground) for the inventory and mapping of irrigated croplands over western ecozones. The approach will utilize TM/TMS and MSS data sets acquired in forest, range, urban and agricultural regions in California. A factorial experiment design will isolate the effects of resolution, radiometry, and spectral character on the information content of TM vs. MSS data. Classification accuracy will be evaluated as a function of sensors (TM/TMS/MSS), the analysis process employed and the level of thematic information extracted. Optimum band combinations of TM and TMS data will be evaluated in agricultural, urban, forest and range situations. Advanced classification techniques will be explored for use with TM data to take account of spatial relationships including texture measures and layered, linear, and/or contextural classifiers. For agriculture applications, TM spectral measures useful in crop separation and irrigation detection will be identified and labelling procedures based on such spectral measures will begin. Resulting TM-based classifications will be evaluated with respect to inventory estimation and mapping objectives.

W84-70648 **677-21-28**
National Space Technology Labs., Bay Saint Louis, Miss.
MULTISENSOR TECHNIQUE DEVELOPMENT
E. F. Zetka 601-688-3833

The objective is to conduct research, utilizing a number of different sensors and analysis methods, to determine basic remote sensing factors/parameters associated with land surface cover, and develop techniques to better discriminate and delineate those land cover forms. The RTOP is comprised of four tasks: (1) utilize the airborne Thermal Infrared Multispectral Scanner to obtain and analyze the quantitative measurement of surface vegetation temperature in the 8 to 12 micron region, and examine TM mid-IR channels for vegetation water content characteristics; (2) analyze SIR-A data over an Alabama study site to determine which basic physical and/or biological properties of land cover have the most effect on microwave radar return and acquire and process dual-polarized, multi-angle A/C 1-band SAR data for the study of vegetation backscatter properties; (3) evaluate quantitative statistical approaches to reduce the data channel dimensionality of LANDSAT-4 TM data; and (4) determine the contribution new wavelength regions (e.g., 1.55 to 2.35 microns) will have on analysis of natural plant communities, as well as in non-natural vegetated areas, under stressed conditions.

W84-70649 **677-21-29**
National Space Technology Labs., Bay Saint Louis, Miss.
LAND RESOURCES DISCIPLINE RESEARCH
Armond T. Joyce 601-688-3830

The general objective of this research is to understand the spectral properties and dynamics of the land resource. For purposes of understanding the various components, separate research tasks will be conducted to address the soil resource vegetation in arid/semiarid regions, and forest vegetation. A ground-operated spectrometer that senses in the LANDSAT thematic mapper bandwidths will be used to determine the basic spectral and thermal properties of the soils and vegetation to be studied. Other data sources will be the LANDSAT Thematic Mapper (TM), Thematic Mapper Simulator (TMS), and the Thermal Infrared Multichannel Scanner (TIMS). Emphasis will be given to understanding the characteristics of soils and vegetation in the mid-infrared and thermal IR regions of the spectrum. This research will be coordinated with various National Science Foundation (NSF) funded Longterm Ecological Research (LTER) studies that have been selected to be compatible with remote sensing and the objectives of this RTOP. Study areas were selected to represent a variety of soils and vegetation types throughout the United States.

W84-70650 **677-21-30**
Lyndon B. Johnson Space Center, Houston, Tex.
LAND USE AND TECHNIQUES FOR MONITORING LARGE SCALE CHANGE IN BIOMASS
M. C. Trichel 713-483-6451

The objectives of this RTOP are to develop and evaluate a sampling and inference strategy optimized for the detection and quantification of land use and biomass changes on a regional or global basis using remotely sensed data and develop and evaluate information extraction approaches for remotely sensed data which support regional and global scale mapping, inventory, and change detection of land use and biomass. The most important determinants of biomass production and accumulation at present appear to be climate, soils, and land use; the most important source of biomass change today appears to be change in land use; therefore, our approach to monitoring changes in biomass is focused on formulating methods to detect and quantify changes in land use, especially those changes in land use which alter the vegetation present.

W84-70651 **677-21-31**
Ames Research Center, Moffett Field, Calif.
USE OF REMOTE SENSING IN BIOGEOCHEMICAL MEASUREMENTS
D. L. Peterson 415-965-5232

The objectives are to: develop techniques using passive remote sensing devices to predict leaf area index, crown closure density, stem density, basal area and height of temperature ecosystems; evaluate these estimates against ground-based dimensional analysis and field radiometric measurements; compare the utility of different sensors (thematic mapper and AVHRR) acting singly, in combination, or over several dates to derive precise estimates; determine the ability of a remote sensing based strategy to estimate the areal extent and spatial distribution of these variables and species distribution for the purpose of extrapolation to much larger areas; and investigate these measures for delineation of ecosystem borders. The approach will be to: conduct correlation analysis of linear combinations of radiometric measurements from remote sensing (TM and AVHRR) with ground-based dimensional analysis across a range of temperature ecosystems including coniferous forest, chaparral, broadleaf evergreen, and grassland in transects in Oregon and California; estimate leaf area index and other structural variables; account for the effects of atmospheric absorption/scattering and differential illumination through ground based radiometric measurements for uniform targets and modeling; using variance/co-variance techniques, determine the precision and variability in these estimates accounting for different spatial and spectral properties of these two sensors; examine the borders between adjacent ecosystems; and coordinate this effort with biological work being conducted with the Life Sciences Division.

W84-70652 **677-22-27**
Goddard Space Flight Center, Greenbelt, Md.
HYDROLOGIC INFORMATION EXTRACTION TECHNIQUE DEVELOPMENT
D. Hall 301-344-6908
(677-29-05)

The components of the hydrologic cycle will be investigated in order to develop an improved understanding of the nature, quantity and distribution of fresh water at the surface of the Earth. Fresh water will be studied in its three states: solid, liquid and vapor. Satellite measurement of areal extent of snow and snowpack properties will be carried out. Watersheds will be studied for hydrologic information: snow covered area, hydraulic conductivity, hydraulic length and stream network. Evapotranspiration (ET) will be studied in terms of energy balance modeling. The approach will be to: (1) exchange results of the U.S./Japan project on snowpack characterization and use aircraft and satellite observations to measure snow covered areas and to characterize internal snowpack properties; (2) use microwave techniques to study hydraulic conductivity of soils, hydraulic length and stream network and use Snowmelt Runoff Models (SRM) to compare predicted and measured flow of streams in snow covered basins in the Himalayas and the MacKenzie River in Canada; (3) U.S. and Japanese scientists will exchange results of the joint project on ET. Energy balance models which employ surface temperature and surface soil moisture observations will be used to estimate ET.

W84-70653 **677-27-12**
Jet Propulsion Laboratory, Pasadena, Calif.
ACTIVE MICROWAVE SPECTROMETER
W. E. Brown 213-354-2110

The long term ojective of this RTOP is to develop, demonstrate, and convert to an operational status a radar spectrometer facility capable of covering the range from 0.3 to 30 GHz. In the near term, the facility capability will be limited to a range from 2 to 18 GHz. The system will be converted to the 100 ft. boom in FY-83. In FY-84, the new configuration will be tested and will be used to obtain data from test sites along the SIR-B flight line.

W84-70654 **677-29-12**
Jet Propulsion Laboratory, Pasadena, Calif.
DIGITAL TOPOGRAPHIC MAPPING SHUTTLE EXPERIMENT
M. Kobrick 213-354-4631

The objectives are to determine the feasibility of performing a digital topographic mapping experiment from the shuttle utilizing a scanning radar altimeter, to determine the engineering characteristics of the instrument, and to develop a mission scenario and experiment plan. The scientific requirements for global topographic mapping will be determined and a trade-off analysis performed with expected sensor performance. Coverage, resolution, shuttle orbit requirements and a data handling and distribution system will be specified. A preliminary system design for the sensor will be developed, including sensor characteristics and expected performance, shuttle interfaces, data link requirements, and data processing. Sensor characteristics and performance will be derived by computer simulation and scaling the known performance of similar instruments. Detailed design and analysis will be performed on the key technological drivers for the sensor; the high frequency transmit/receive (T/R) modules and the large phased array antenna. In the case of the T/R module, some testing will be done on prototype hardware developed under another program.

W84-70655 **677-29-22**
Jet Propulsion Laboratory, Pasadena, Calif.
LUMINESCENCE DETECTOR FROM SPACE
J. B. Breckinridge 213-354-6785

The overall objective of this RTOP is to evaluate the use and design approach of an orbital luminescence mapping sensor using Fraunhofer Line Discriminator (FLD) techniques. A study performed under RTOP 677-29-22 indicates that a staring-mode, mapping orbital FLD is feasible assuming certain luminescence efficiencies. The work proposed here includes development of a portable FLD to be used to measure luminescent efficiencies. The technical objectives are, (1) to design, fabricate, and test a portable FLD, (2) to collect ground survey data of luminescence measurements and interpret the geologic information to determine the utility and parameters of an orbital FLD, and (3) to verify a shuttle-borne FLD design approach by computer modeling. The technical approach will be to apply optical systems engineering skills to design and fabricate a portable FLD. Field experience and study indicate that a portable FLD of new design is needed to verify the suitability of an orbital FLD. Two activities are proposed for this year, (1) an analysis of orbital design approaches to indicate the optimum approach for the portable FLD, and (2) design, fabrication and test of the portable FLD to measure luminescence in ground studies.

W84-70656 **677-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
TIMS DATA ANALYSIS
A. B. Kahle 213-354-7265
(677-48-04)

The overall objective is to evaluate the geologic utility of multispectral thermal infrared surveys using the newly built Thermal Infrared Multispectral Scanner (TIMS). We will determine the lithologies that can be effectively discriminated on the basis of the TIMS measurements, either alone or in combination with other remotely sensed data sets. We will examine the physical basis for the rock type discrimination capabilities achieved by the TIMS, including spectral emissivity of rocks and soils, thermal inertia, and diurnal thermal history of the surface material. The TIMS data will be acquired over a wide range of geologic environments, including sedimentary basins, plutonic batholiths, recent volcanic areas, metamorphic terrain, with varying degrees of weathering and vegetative cover. Data will also be acquired with complementary instruments such as the thematic mapper simulator (NS-001), the airborne imaging spectrometer (AIS), and preexisting orbital radar where possible (SEASAT, SIRA) or by SIR-B. Image processing will include production of emisssivity images, noise removal, registration of complementary data sets, and statistical analysis. Laboratory and field studies of the emission properties of natural materials will be undertaken to support the analysis and interpretation of the TIMS data. A library of laboratory and field emission data will be created. The TIMS will be calibrated under controlled laboratory conditions and the results documented and made available to investigators.

W84-70657 **677-41-07**
Jet Propulsion Laboratory, Pasadena, Calif.
ROCK WEATHERING IN ARID ENVIRONMENTS
A. r. Gillespie 213-354-6927
(677-41-25; 677-46-02; 677-41-03; 677-41-09; 677-41-27)

The objective of this program is to determine the different rates of chemical and mechanical processes that contribute to the weathering of rocks in arid environments. Remote sensing methods appropriate to the measurement of weathering products will be evaluated as new techniques to aid in relative dating and age ranking of geologic deposits and in geologic mapping of lavas and weathered deposits commonly found in arid regions. These methods will utilize image data spanning the spectrum from 0.4 micrometers to 25 cm, in the visible-reflective infrared, thermal infrared, and radar regions. We intend to apply these methods to a wide variety of arid test sites to determine whether the chemical alteration of rock surfaces and the mechanical breakdown of rock particles proceeds in a consistent fashion in areas of similar lithology and climate. The work proposed in this RTOP will involve collaboration of researchers from JPL, the University of Washington, and Arizona State University. We will study lava flows and coarse clastic deposits such as alluvial fans, glacial moraines, and river terraces, all of which are typical for arid regions of the western United States. Specific topics will include: (1) development of soils and caliche; (2) changes in surface roughness characteristics and clast size distributions; (3) development of surface stains and coatings of Fe and Mn oxides, clays, and silica gels; and (4) destruction of glassy rinds on pahoehoe and the development of duricrusts on granitic rocks and sandstone. Vegetation changes accompanying weathering will be studied under related RTOP 677-41-09. An effort will be made to improve chronologic data, in order to better identify weathering rates. Chemical and mechanical changes accompanying weathering which are detectable remotely will be studied by conventional geochemical and petrographic

means. Relative ages of studied geologic units will be determined by conventional and innovative methods. Study areas will be established in California, Nevada, Idaho, Oregon, Utah and Hawaii.

W84-70658 **677-41-13**
National Space Technology Labs., Bay Saint Louis, Miss.
GEOLOGICAL REMOTE SENSING IN MOUNTAINOUS TERRAIN
D. L. Rickman 601-688-3833

It is the purpose of this project to determine the utility of thematic mapper data (initially through simulation) as integrated with thermal infrared multispectral scanner data in the detection and mapping of hydrothermally altered rocks and the associated original lithologies. The target area will be a mountainous terrain, with varying degrees of vegetative cover. A secondary objective will be to examine the relative significance of some of the several components in a lithology's heat budget vs. the emissivity. Thematic Mapper Simulator (TMS) data has been acquired over selected targets in the Southwest of the United States. Thermal Infrared Multispectral Scanner (TIMS) data for the test sites will also be acquired. All data sets will be georeferenced. Digital topographic data will also be integrated, and will be used as necessary to compensate for terrain effects in the TMS data. Using TMS data and previously developed techniques, areas of hydrothermal alternation characterized by abundant hydroxyl and ferric iron will be emphasized. Using TIMS data, lithologies will be discriminated based on their silica content, using stretched inverse principal components and canonical analysis methods. Results from TMS data will be compared and contrasted to the results from the TIMS data output. This analysis will guide manipulation of the integrated data sets. This overall research will ultimately yield products which represent argillic, ferric and silica alteration zones from a wide range of lithologies.

W84-70659 **677-41-17**
Jet Propulsion Laboratory, Pasadena, Calif.
CHROMITE TEST CASE STUDY
A. R. Gillespie 213-354-6927
(677-41-03; 677-41-07)

The main objective of this study is to evaluate the utility of remote sensing techniques for geologic mapping in areas of known chromite and nickel occurrences. Other objectives are to: (1) determine the ability to discriminate various ultramafic rock types; (2) study the association of vegetation species/communities with rock type; and (3) identify possible vegetation anomalies due to substrate chemistry. The test site area is located in northern California-southern Oregon in the Josephine Ophiolite Complex. Mineral deposits are associated with ultramafic rocks which consist of dunite, wehrlite, harzburgite and serpentinite. The site has moderate relief, and vegetation cover varies from 20 to 30% to 100%. The approach to be used in this year of the study consists of several stages. Further computer image processing at JPL's Image Processing Laboratory will be performed on the three aircraft multispectral scanner data sets obtained during FY-82. The NS-001 thematic mapper data, DMS 11-channel data, and TIMS thermal multispectral scanner data have been co-registered to a topographic base. Geologic maps were digitized and registered to the same base. This combined data set will provide the remote sensing data which will be examined for geologic and geobotanical information related to rock type discrimination and vegetation mapping. The TMS aircraft data will be compared and contrasted with LANDSAT-D thematic mapper data if data is available during FY-83. Further field work will be undertaken to verify results from the analysis and interpretation activities. Anomalous areas will be visited to determine the cause of the image features. Field reflectance measurements will be obtained where necessary to supplement existing data. Work will continue to be done in cooperation with Dr. D. Mouat at ARC and Dr. J. Adams of the University of Washington. Data exchange and synthesis of results in adjoining areas will allow a more regional study to be performed, without duplication of efforts.

W84-70660 **677-41-19**
Jet Propulsion Laboratory, Pasadena, Calif.
SMIRR DATA ANALYSIS
A. F. H. Goetz 213-354-3254

The objective of this effort is to continue to evaluate the utility of narrow-band radiometer data obtained on STS-2 by the shuttle multispectral infrared radiometer (SMIRR) for geologic remote sensing. It already has been shown that SMIRR data can be used for direct identification of clays and carbonate rocks in arid environments. The objective this year will be to substantiate the findings in other parts of the world and to attempt to identify additionally, micaceous materials, gypsum, and alunite. The effects of vegetation on the analysis of spectral measurements in the 2-2.5 um region will be assessed to determine at what level of coverage rocks and soil identification can still be made. The approach to be taken will include: (1) the selection of appropriate portions of the data set that are in regions when potential mineral identification is considered possible; (2) calibration of the data segments to remove both atmospheric and instrument effects; (3) analysis of both linear plots of ratio values and individual spectra; and (4) ground sample collection and in situ measurement with a radiometer and a high resolution spectrometer. This effort will be carried out in cooperation with Dr. Lawrence Rowan of the USGS.

W84-70661 **677-41-24**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTISPECTRAL ANALYSIS OF SEDIMENTARY BASINS
H. R. Lang 213-354-3440

The primary objectives are to: (1) evaluate the combined utility of remote sensing measurements performed at visible, infrared, and microwave wavelengths, in both passive (reflectance, emission) and active (radar) modes, for mapping subtle variations in the lithology of sedimentary rocks; (2) apply space-acquired remote sensing data to geological mapping problems encountered in a large scale sedimentary basin (dimensions on the order of 100x100 kilometers or greater); (3) compare the types of lithologic information that can be extracted from remotely sensed data with the types of information that are commonly obtained with conventional field mapping techniques; and (4) employ information derived from remote sensing surveys to constrain models of basin formation and evolution. The general approach is to perform the following as a collaborative effort by participants from the Geology and Radar Remote Sensing Groups at JPL and the University of Hawaii: (1) acquire multisensor, multispectral, remotely sensed data at visible, infrared, and microwave wavelengths over a large basin containing a wide variety of sedimentary rocks (emphasis will be on existing orbital data, e.g., TM, HCMM, and SEASAT SAR); (2) spatially co-register each data set to a digital topographic model and process and calibrate data to maximize lithologic information; (3) apply statistical pattern recognition techniques to the combined remotely sensed data to identify the combined image spectral and textural characteristics of sedimentary rocks; (4) conduct regional scale lithologic mapping throughout the basin using existing orbital data sets (smaller areas within the basin will be mapped in greater detail employing experimental airborne sensors, e.g., AIS, TIMS, L-band SAR, etc.); (5) develop an experimental plan that establishes a scientific rationale for the collection, compilation and analysis of remote sensing and other geophysical surveys for detailed evaluation of basin formation and evolution. Laboratory and field studies will be performed in support of the analyses.

W84-70662 **677-41-25**
Jet Propulsion Laboratory, Pasadena, Calif.
AIS DATA ANALYSIS
A. F. H. Goetz 213-354-3254

The major objective is to collect and analyze high resolution spectral images in the 1.2 to 2.4 microns region in order to evaluate their utility for geologic remote sensing. Additionally, after adding a pointing capability to the Airborne Imaging Spectrometer (AIS), an additional objective will be to develop mathematical procedures for inferring the magnitudes of atmospheric absorption and scattering effects in high resolution spectral images. The airborne

imaging spectrometer is a test bed for area array detector development in the imaging spectrometer program. As part of the detector evaluation program, flights are made over various terrains. The flights will be chosen to cover areas of sedimentary, metamorphic and igneous rock exposure. Additional targets will be areas of natural vegetation cover and geobotanical anomalies. New data reduction and analysis techniques will be developed to make full use of 128 channel spectral images for direct detection of materials. Pattern recognition techniques as opposed to statistical methods will be emphasized.

W84-70663 **677-41-26**
Jet Propulsion Laboratory, Pasadena, Calif.
MRSE GEOLOGICAL INVESTIGATIONS
J. B. Cimino 213-354-4631

In September, 1983 Spacelab 1 will be launched into orbit aboard the shuttle. One of the key instruments on Spacelab is the Microwave Remote Sensing Experiment (MRSE), an X-band (3.2 cm) radar system with a fixed 45 degree look angle and HH or VV polarization. The MRSE is designed and built by DFVLR and is capable of acquiring an 8.5 km swath of digital data with about 25 m resolution. The MRSE operates in several modes; the one we are interested in for this study is the synthetic aperture imaging mode. Two passes, one ascending and one descending, will be imaged over the U.S. Several months later in August, 1984, the second shuttle imaging radar, SIR-B will be launched into orbit on STS-17. The SIR-B, like MRSE is a synthetic aperture radar with HH polarization, digital data acquisition capability and acquires data at a 45 degree look angle (the antenna is tiltable). Unlike MRSE, however, SIR-B is an L-band system (23 cm). Although the missions will be flown several months apart, their orbits are very similar (57 degree inclination and 220 km altitude for SIR-B and 250 km altitude for MRSE), therefore it should be possible for the first time to compare spaceborne imagery acquired at two different wavelengths. The dual frequency data will allow a better determination of surface roughness spectra of geologic features due to the broader range of roughness scales which are detectable. Radar images obtained at X-band by MRSE can be used to quantify surface roughness spectra at a complementary scale to the L-band data. Measurements of geologic surfaces at both X-band can be used to determine the rock size frequency distribution of geologic targets which can in turn be used to infer rock types and ages through their erosional characteristics.

W84-70664 **677-41-27**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTISPECTRAL ANALYSIS OF BATHOLITHS
A. R. Gillespie 213-354-6927
(677-41-03; 677-41-25; 677-41-07)

This RTOP continues one phase of the work conducted under RTOP 677-41-03, improved Rock Type Discrimination. Pertinent results from this earlier RTOP are reported herein. The objective of this program is to evaluate the utility of visible, near-visible, and thermal infrared spectra and multispectral images for lithologic mapping in areas containing exposures of granitic and other plutonic rocks. The approach is to acquire high-resolution spectra in the region 0.4 to 2.5 and 8 to 14 microns for rock samples in the field and in the laboratory. From analysis of these data, parameters that discriminate well among the various plutonic rock types will be devised and tested. These parameters will be chosen such that they may be calculated from image data as well as from the high-resolution spectra, and images portraying the parameters most effective at discriminating among the plutonic rocks will be calculated from the acquired image data. These images will be interpreted and compared to existing maps of rock types. In particular, we will assess the utility of processed multi-channel thermal infrared images for detecting variations of silica content in igneous rocks, such as may be caused either by episodic intrusion or by compositional zonation within a single pluton. In addition, we will assess the utility of visible and near-infrared images for detecting chemical alteration associated with low-grade metamorphism of plutonic rocks. Specific topics to be studied this year include: (1) evaluation of visible and near-infrared images acquired during FY-82 and FY-83 over the Sierra Nevada batholith and over the Idaho batholith and other regions; (2) evaluation of TM images of the test areas; (3) acquisition and evaluation of multichannel thermal IR images of at least the southern Sierra batholith; (4) acquisition and analysis of field and laboratory spectra; (5) acquisition and analysis of high-spectral-resolution AIS images of igneous rocks from the study areas; and (6) petrographic analysis of the rock samples from the study areas. Goals 3 and 5 will be conducted under related RTOPs 677-41-03 and -07, respectively.

W84-70665 **677-41-28**
Goddard Space Flight Center, Greenbelt, Md.
ROCK TYPE DISCRIMINATION USING ORBITAL MULTISPECTRAL THERMAL INFRARED SURVEYS
H. W. Blodget 301-344-8997

Evaluate the utility of orbital multispectral surveys conducted at Thermal Infrared (TIR) wavelengths for lithologic mapping. Specifically determine those types of rocks that can be spectrally distinguished on the basis of natural variations in surface thermal emission at wavelengths of 3 to 5 and 8 to 14 micrometers. Orbital measurements of terrestrial thermal emission obtained with the NOAA-7 AVHRR and NIMBUS-5 SCMR sensors will be digitally merged to construct false color composite images of the Earth's surface. These images will be based upon multispectral infrared data acquired by the AVHRR and SCMR in bands centered at wavelengths of 3.7 (AVHRR), 8.8 (SCMR), 10.8 (AVHRR, SCMR), and 12.0 (AVHRR) micrometers. Merged data sets will be constructed over two test site areas in the Arabian Peninsula containing a wide variety of igneous, metamorphic, and sedimentary rocks. These data sets will be used to detect apparent variations in the emissivity properties of surficial materials. In addition, day/night thermal emission obtained with the AVHRR will be used to detect regional variations in the apparent thermal inertia of surficial materials. Spatial and temporal variations in surface emission observed in these surveys will be used to experimentally distinguish various types of rocks and soils exposed within the test site areas. Lithologic boundaries detected will be compared with rock units displayed on existing geological maps. LANDSAT-4 thematic mapper data may be acquired and merged with the AVHRR and SCMR data sets if positive results are achieved during the initial phase of this project.

W84-70666 **677-42-01**
Goddard Space Flight Center, Greenbelt, Md.
MINERAL-INDUCED STRESS IN VEGETATION CANOPIES
M. L. Labovitz 301-344-5600
(677-42-07)

Objectives are to: (1) evaluate the geologic utility of remote sensing surveys conducted at visible and reflected infrared wavelengths as well as laser induced fluorescence for the specific purpose of detecting mineral-induced stress conditions in areas of dense vegetation; (2) conduct detail field surveys of leaf reflectance within a deciduous forest canopy throughout the growing season; (3) investigate potential correlation between leaf reflectance, fluorescence, and soil geochemistry at different stages of the growing season; and (4) assess spatial variability in the reflectance characteristics of a natural deciduous canopy through analysis of aerial and orbital thematic mapper data. The approach will be to: complete analysis of ground-based reflectance measurements and aerial/orbital multispectral surveys and performed in northern Virginia during the 1983 field season; conduct analysis of Lidar measurements performed during 1983 and 1984 field season; identify suspected anomalies in local soil geochemistry on the basis of reflectance measurements; compare predictions with soil chemistry maps where available; assess the accuracy of initial predictions in a quantitative fashion; and determine whether variations in leaf reflectance properties are characteristically associated with mineral-induced stress can be identified in multispectral surveys of extended vegetation canopies.

W84-70667 **677-42-04**
National Space Technology Labs., Bay Saint Louis, Miss.
GEOBOTANICAL MAPPING IN METAMORPHIC TERRAIN (SOUTHERN APPALACHIAN MOUNTAINS)
W. G. Cibula 601-688-3833

The objective is to develop and evaluate practical techniques for using the thematic mapper (initially through simulation) and other airborne and space sensor systems for geobotanical mapping. The emphasis will be on ore bearing terrains in areas which are moderately to heavily vegetated. Geobotanical methods involve the use of surface vegetation to help identify the nature and properties of the substrate. The two aspects that are believed to be identified by remote sensing means are: (1) differences in plant community structure, and (2) the effects of mineral stress in the plant community. Data processing will include the development of spectral pattern recognition outputs, since pattern recognition is effective in emphasizing minute detail in spectra data and therefore is capable of finding subtle geobotanical relationships. Field verification of results is central to the project. Concurrently, geological data from other sources, e.g., geologic quad sheets which are available for the site, will be obtained and compared to the spectral data map products.

W84-70668 **677-42-07**
Goddard Space Flight Center, Greenbelt, Md.
GEOBOTANICAL MAPPING IN METAMORPHIC TERRAIN (CENTRAL APPALACHIAN MOUNTAINS)
E. J. Masuoka 301-344-5600
(677-42-01; 677-42-04; 677-43-12)

The objectives are to evaluate the combined utility of remote sensing surveys conducted at visible, infrared, and microwave wavelengths for lithologic and structual mapping in vegetated terrain and to empirically identify botanical variations within a mixed forest canopy (deciduous+conifer) and relate these variations to the lithology of underlying geological materials. The FY-84 activities will primarily focus upon two or more small scale test sites (on the order of 10x10 kilometers in size) situated in the vicinity of Winchester, Virginia. Data acquired with the LANDSAT-4 thematic mapper, the airborne thermal infrared multispectral scanner, SEASAT synthetic aperture radar (SAR), and the L-band SAR on NASA's CV-990 aircraft will be geometrically rectified and digitally co-registered over the test sites. Digital terrain models will be developed for each site and used to remove topographic effects that are present in each set of remotely sensed imagery. A variety of statistical pattern recognition techniques will be applied to the combined data sets to determine the extended spectral signatures of local vegetation communities. Field studies will be performed to relate these empirically derived spectral signatures to local variations in botanical and geological conditions.

W84-70669 **677-42-08**
Jet Propulsion Laboratory, Pasadena, Calif.
REFLECTANCE PROPERTIES OF LEAVES
B. N. Rock 213-354-6229
(677-41-07; 677-41-17; 677-42-09)

The primary objectives are: (1) to establish and operate a microtechnical facility which will provide equipment for the embedding, sectioning, staining, and microscopic study of leaf tissues from selected native species; along with assessment of leaf chlorophyll content and leaf moisture content; (2) obtain continuous high resolution laboratory spectra of individual leaves of these same native species, utilizing the Beckman 5240 recording UV spectrophotometers; (3) acquire continuous high resolutions field spectra of individual leaves and crowns of these native species, utilizing the PFRS and the GER high resolution field instrument; (4) acquire high spectral resolution AIS (airborne imaging spectrometer) data for selected field sites;(5) to compare the laboratory, field, and AIS high spectral resolution leaf and crown spectra with the leaf anatomy/chemistry of each species. The general approach is to establish a microtechnical facility at JPL and collect, section, and study mesophytic leaf specimens of a variety of species of oaks (multiple species of the same genus) in various stages of growth and senescence (collections made during growing season and on into the fall) from the Lost River, West Virginia, study site. High spectral resolution VNIR and SWIR field and airborne spectra of each species will be collected at the same time. Leaf specimens will be collected for the purpose of producing laboratory spectra in the VNIR and SWIR, both of intact leaves and pigment extracts. Similar collections of both leaf specimens and spectral data (laboratory, field, and AIS) will be made for species possessing xerophytic leaf modifications and stunted and stressed vegetation (geochemically induced) from Pico Anticline, CA, and the Josephine ophiolite complex in southern Oregon. An interim report will be prepared for publication comparing leaf and canopy reflectance properties with anatomical and chemical characteristics acquired from each of the field sites.

W84-70670 **677-42-09**
Jet Propulsion Laboratory, Pasadena, Calif.
ARID LANDS GEOBOTANY
B. N. Rock 213-354-6229
(677-41-07; 677-42-08)

The primary objectives are to: (1) evaluate the utility of remote sensing measurements obtained at visible, thermal (both reflected and emissive), and microwave wavelengths for detecting trace amounts of surface vegetation in arid lands where vegetation cover typically ranges for 0 to 50%; determine the optimal combination of remote sensing systems, techniques, and multitemporal data sets for assessing the amount and type of vegetation present in pixel-sized areas (25 to 50 meters square); and evaluate the utility of using phenologic and physiologic variation in selected desert species as geobotanical indicators of subsurface conditions. The general approach will be to perform the following in conjunction with selected universities and other government agencies: (1) select and develop a number of study sites which are characterized as representative of the major desert/arid ecosystems in the United States, capable of providing examples of variables such as density of plant cover, concentrations of xerophytically modified vegetation types (sclerophylls, succulents, tomentose species, etc.), and/or processing geobotanical anomalies; (2) study the connection which exists between physiological processes such as photosynthesis and transpiration and remotely sensed data acquired in the visible, infrared and microwave portions of the EM spectrum; (3) extensive field studies coupled with aircraft overflights by AIS (airborne imaging spectrometer), NS-001 (a version of the thematic mapper simulator or TMS), TIMS (thermal infrared multispectral scanner), L-band SAR (synthetic aperture radar), and L-band, C-band scatterometers will be conducted at these sites (also, data from the German Microwave Remote Sensing Equipment (MRSE) may be available in the Arizona area); and (4) conduct periodic workshops to allow incorporation of input from the botanical research community. These data, combined with existing multitemporal, multispectral data for the sites, will be used to determine the optimal combination of observational techniques and strategies that are best suited for vegetation mapping in arid lands.

W84-70671 **677-43-17**
Jet Propulsion Laboratory, Pasadena, Calif.
TOPOGRAPHIC MAPPING METHODS
M. Kobrick 213-354-4631
(677-43-16; 677-46-02)

The objective of this study is to understand the applications of and optimum techniques for measuring topography from orbit. We will attempt to determine the optimum automatic stereo-correlation algorithms for digital radar stereo image pairs. Algorithms developed during the previous year will be modified to incorporate alternate correlation procedures such as the use of varying windows and nonlinear coefficients, cultural and specular targets, and ground control. Test data sets will include simulated images and SEASAT images where relief is relatively low. An extensive library of algorithms has been developed under this RTOP for digital topographic file manipulation and analysis, radar image processing, image simulation, and rectification, registration and radiometry. This year we will document these algorithms and develop them into the DESIREE (digital evaluation system for imaging radar elevation effects) system, which will be adaptable

to any general purpose computer system in a manner similar to the VICAR image processing system. A set of prototype algorithms will be developed for the digital reduction of Shuttle Scanning Radar Altimeter (being developed under a separate RTOP) data. Digital topographic maps will be used to generate simulated radar echoes which will be processed by the prototype software into time-delay information, elevation arrays, and eventually topographic map products in various forms (digital files, contour maps, etc.). The processing will include shuttle ephemeris information, ground control and other corollary data to evaluate data throughput and determine the most efficient computational procedures or streamlining the generation of topographic map products.

W84-70672 **677-45-06**
Goddard Space Flight Center, Greenbelt, Md.
DETERMINATION AND INVERSION OF CRUSTAL MAGNETIC FIELDS
R. A. Langel 301-344-6565

The major objectives of this program are: (1) to verify the validity of reduction to pole techniques at the geomagnetic equator and continue optimization and development of the equivalent source software; (2) to complete and publish the global POGO and MAGSAT magnetic anomaly maps; (3) to investigate and apply techniques of filtering external fields from anomaly data and of selecting data in which such efforts are minimal and apply these methods to derive a revised MAGSAT anomaly map; and (4) to devise a method to minimize the effects of attitude solution changes on MAGSAT anomaly data. Smoothing and accuracy criteria for equivalent source solutions will be developed and tested by comparison with data. Individual data plots from MAGSAT dawn and dusk, will be compared to each other, to POGO, and to existing external field predictions. The apparent external fields will be identified and characterized and MAGSAT data selected to minimize these effects. Fourier and cross-spectral filters will be investigated to see if they improve the elimination of external fields. Maps will be generated and published.

W84-70673 **677-46-02**
Jet Propulsion Laboratory, Pasadena, Calif.
NEW TECHNIQUES FOR QUANTITATIVE ANALYSIS OF SAR IMAGES
D. L. Evans 213-354-2418
(677-41-24; 677-42-10; 677-41-07)

Analysis of images from the Shuttle Imaging Radar-A (SIR-A) and SEASAT SAR have shown their spaceborne radar images provide quantitative information about geologic conditions and processes on a global scale, and that the addition of multiple viewing geometries increases the amount of geologic information derivable from SAR images. Analyses of multipolarized and multifrequency aircraft SAR images further indicate that radar can provide information about intrinsic physical properties of geologic surface materials. Both radar image texture and tone provide useful geologic information. Depending on the geologic problem, either radar image tone or texture information alone, or in conjunction with data from images obtained in other portions of the electromagnetic spectrum may provide the most useful data set. The objective of this RTOP are to develop and implement new techniques for quantitative analysis of radar image texture and tone that can be applied to the mapping of rock types and structures, both exposed and obscured by vegetation canopies or alluvial cover. The approach will be to test and evaluate various methods for extraction of radar texture and tone information from existing data sets and those acquired by SIR-B, and to determine the effect of polarization and frequency on image texture and tone, using an aircraft system, in order to define experiments needed to better understand and utilize data obtained by future Shuttle Imaging Radar missions with multipolarization and multifrequency capabilities. This proposal covers the continuation of a basic research effort at JPL involving the development and implementation of new techniques for analyzing SAR images for the three year period of FY-83, FY-84, and FY-85. It represents the efforts of four researchers who will be addressing techniques for different geologic problems involving scattering from vegetation canopies, subsurface penetration, relationship between lithology and radar image texture and relationship between lithology and radar image tone.

W84-70674 **677-46-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SENSITIVITY AND PRECISION OF AIRBORNE MULTISPECTRAL SCANNERS
J. E. Conel 213-354-4516
(677-41-03; 677-41-25)

Multispectral scanners record solar radiance transmitted through the atmosphere and reflected from the surface. The radiances include directional atmospheric scattering and attenuation effects and instrumental factors that must be removed or evaluated before interpretation of the data surface spectral reflectance. The surface reflectance is a bi-directional function of incidence, reflectance, and azimuth angles. The objectives are: (1) to evaluate methods for removal of the atmospheric and instrumental effects, including empirical and theoretical modeling approaches; (2) to establish a mathematical relationship between the digital output of an airborne multispectral scanner and surface reflectance properties; (3) to estimate the overall signal/noise characteristics of scanner measurements under specified conditions of instrument performance, illumination, and atmospheric attenuation; and (4) to estimate NE delta rho for scanner data under normal conditions of observation. The NS-001 data will be obtained over a variety of test sites containing natural and artificial deployed target surfaces. In situ ground based observations will be conducted during over-flights to: (1) specify reflectance of targets and surfaces and (2) assess conditions of the atmosphere. Multiple observations over standard areas will be made to establish surface scatter and observation of standard references made in time series to establish variability of the atmosphere. These data will be analyzed statistically to establish overall signal/noise estimates for the scanner. Multiple site observations will be used to assess generality of the result. Atmospheric effects will be evaluated: (1) through a direct comparison of the scanner digital output and ground reflectance data, and (2) through use of new generalized theoretical models of the atmosphere and surface. A method of analyzing the atmosphere utilizing halo effects in air photos will also be explored.

W84-70675 **677-47-03**
Jet Propulsion Laboratory, Pasadena, Calif.
AIRBORNE RADAR RESEARCH
W. E. Brown 213-354-2110
(677-47-07)

The objective of this RTOP is to develop the NASA-JPL aircraft radar facility to meet the specific needs of the NASA remote sensing program. This RTOP covers a three year upgrade program for the facility which incorporates a C-Band SAR and additional onboard digital data handling capability to make the facility compatible with research and development needs in preparation for shuttle reflights such as the proposed SIR-C program and for data utilization from free-flyers such as the ERS-1 satellite both of which contain C-Band SAR imagers. The C-Band radar design, Phase 1, incorporates the L-Band radar exciter and receiver by using up and down converters to cover the operating frequency of 5275 MHz. The design was completed in FY-83. In FY-84, the fabrication will be completed and tested. In FY-85, the C-Band radar will be made independent of the L-Band radar so that quad-pol data can be obtained at both L and C-Bands simultaneously. Other radar improvements including a digital gate, and 8-bit floating point ADC will also be completed in FY-84.

W84-70676 **677-47-07**
Jet Propulsion Laboratory, Pasadena, Calif.
AIRBORNE RADAR MAINTENANCE AND OPERATIONS
T. W. Thompson 213-354-3792
(677-46-02; 677-41-07; 677-41-24)

There are three major objectives of this RTOP. The first objective is to maintain the L-Band SAR and the L-Band/C-Band scatterometers in operational readiness for data acquisition missions. The second objective is to operate these radars in a

five-week SIR-B underflight program. The third objective is to reduce the data from the SIR-B underflights and previous missions sponsored by the RTOP. The NASA-JPL L-Band SAR was brought to operational readiness in FY-83. This system was placed under configuration control. Supporting documentation for: (1) system maintenance, (2) operational procedures, (3) system performance, (4) pre-mission test procedures, and (5) experiment cost estimating was completed. The NASA L- and C-Band scatterometer was transferred to JPL in FY-83 and was also brought to near operational readiness in FY-83. The L-Band SAR and L-Band/C-Band scatterometers will be maintained throughout FY-84. This will be done by monthly health checks and system tests. During the time of the SIR-B orbital operations, the L-Band SAR will be installed on the NASA/Ames CV-990 aircraft and operated in a 5-week, 12 flight mission. Also, the L-Band/C-Band scatterometer will be installed on the NASA/Ames C-130 aircraft and operated in a 5-week before SIR-B launch, 1 flight one week before SIR-B launch, 8 flights during SIR-B mission, and 2 flights after SIR-B.

W84-70677 **677-48-01**
Jet Propulsion Laboratory, Pasadena, Calif.
ER SEASAT DIGITAL SAR PROCESSING
T. A. Andersen 213-354-3964
(661-80-34)

The objective of this RTOP is to process SEASAT radar data to produce synthetic aperture radar images of land areas in North and Central America in support of geologic research application investigation studies. The processing will be performed using the upgraded Interim Digital Processor (IDP) in JPL. Each image will exhibit a 25 meter resolution and cover a 100 km square target area. At least 20 images will be produced in FY-84.

W84-70678 **677-48-04**
Jet Propulsion Laboratory, Pasadena, Calif.
AIS/TIMS DATA REDUCTION
J. E. Solomon 213-354-2722
(677-41-13; 677-41-25; 677-41-03; 677-42-07; 677-42-04)

This work addresses the problem of data reduction and distribution of airborne multispectral image data acquired with the Thermal Infrared Multispectral Scanner (TIMS) and Airborne Imaging Spectrometer (AIS) instruments. The instrument data will be put in a form suitable for transfer to scientific investigators on computer compatible magnetic tape (CCT). Procedures will be developed for radiometric rectification, cataloging, and data base retrieval with data formatting for distribution in standard form on CCTs to scientific investigators.

W84-70679 **677-48-05**
National Space Technology Labs., Bay Saint Louis, Miss.
TIMS DATA COLLECTION AND REDUCTION
R. M. Barlow 601-688-1929
(677-41-13; 677-42-04; 677-41-03)

The objective of this project is to employ the newly developed Thermal Infrared Multispectral Scanner (TIMS) to conduct airborne surveys of preselected test site areas in support of RTOP investiagations being sponsored by the Non-Renewable Resources Program. The data resulting from these overflights will be reformatted, radiometrically corrected, (if required by investigation) and delivered as computer compatible tapes to approved investigators.

W84-70680 **677-60-15**
Ames Research Center, Moffett Field, Calif.
REMOTE SENSING APPLICATIONS FOR FACILITY SITE SELECTION AND WASTE DISPOSAL IMPACT ASSESSMENT
David A. Mouat 415-965-5896

The overall objectives of this RTOP are to develop and test analytical techniques involving the characteristics of the thematic mapper to generate screens (or factors) for facility site selection and waste disposal impact assessment. Secondary objectives involve testing the dynamic range, spectral and spatial resolution of the thematic mapper in order to meet the overall objective. In order to test these sensor characteristics, new, improved and/or reformatted analytical techniques must be developed and evaluated. The overall approach involves the selection of test sites situated within diverse ecosystems which are well suited for waste disposal impact assessment and facility siting in coordination with Woodward Clyde Consultants. The use of airborne scanner data to simulate the TM's sensor characteristics will occur prior to the availability of the thematic mapper data. The approach involves several analytical procedures. Optimal waveband combination will be accomplished in order to optimize separation of water features, semiarid land cover features, and geologic features. Various types of classification procedures will be attempted on the different data sets.

W84-70681 **677-60-19**
Ames Research Center, Moffett Field, Calif.
USE OF THEMATIC MAPPER DATA FOR UTILITY CORRIDOR ANALYSIS AND SITING
E. H. Bauer 415-965-5513

The objective of this project is to evaluate Thematic Mapper (TM) and Thematic Mapper Simulator (TMS) digital data as a source for the identification and mapping of features impacting utility corridor siting. The project will examine various problems previously noted when using a LANDSAT MSS data in electric transmission line routing analysis. The approach will be to acquire TMS, TM and ground data sets for agricultural, riparian, and rural urban regions in California. Spectral clustering and texture analysis techniques will be developed and assessed for the identification of vineyards, tomatoes, and rice crops which affect transmission line siting. Edge/linear detection algorithms will be evaluated as tools for mapping the agriculture infrastructure. Contextual classifiers, and texture techniques will be examined for effectiveness in riparian vegetation, small water bodies, and rural urban development mapping. A per field classifier based upon image segmentation through use of edge information will be developed as a tool for accomplishing both data reduction and improved classification on TM data.

W84-70682 **677-60-20**
Goddard Space Flight Center, Greenbelt, Md.
HYDROLOGIC FEATURE DEFINITION JOINT RESEARCH PROJECT
J. C. Gervin 301-344-7061

This four year joint research program with the Corps of Engineers (Corps) will evaluate the capabilities of LANDSAT TM/TMS data in a wide range of water resources and related environmental models used in a geographic information management system. Activities in phase 1 (of four) have focused on the comparison of information obtained from TMS data with MSS and conventional data. Several study sites have been analyzed representing a variety of geographic environments and technical challenges, incuding two suburban watersheds, a coastal estuary, and a major inland waterway. The TMS data produced a more accurate and spatially contiguous land cover classification than MSS, due to both increased spatial and spectral resolution. A four-band TMS data set selected using the transformed divergence technique produced a classification almost as good as the seven-band, a promising result for effective band selection. Phase 2, the evaluation of TM data, has already begun. Land cover classification accuracy of TM data will be compared with that of MSS, and the contribution of spatial, spectral and radiometric characteristics to classification accuracy will be examined in detail. Techniques for improving TM classification accuracy will be evaluated. The TM band selection studies will continue. The ability of TM data to discriminate wetland communities and water parameters, wildlife habitats, and tidal circulation will be examined. A detailed separation of developed categories for flood damage modeling will be attempted.

W84-70683 **677-80-27**
Goddard Space Flight Center, Greenbelt, Md.
A PICTORIAL ATLAS OF REGIONAL LANDFORMS FROM SPACE
N. M. Short 301-344-7870

The objective is to provide approximately 225 LANDSAT, SEASAT, SIR-A, HCMM, and Gemini/Apollo images and accompanying text. This atlas will establish a technical baseline for a new approach to the descriptive and genetic aspects of geomorphology which characterizes the nature and development of landforms and terrains at regional scales using space imagery as the major data source.

Advanced Studies -- Explorers

W84-70684 **689-09-01**
Goddard Space Flight Center, Greenbelt, Md.
FAR ULTRAVIOLET SPECTROSCOPIC EXPLORER (FUSE)
A. Boggess 301-344-5103

To perform studies leading to a satellite astronomy observatory that will operate as an international guest observer facility to conduct astronomical spectroscopy in the UV spectral range from 1200A to shorter wavelengths, with 100A as the short goal. A range of spectral resolving powers from approximately 100 to 100,000 is desired in order to perform studies of objects in the solar system, of stellar atmospheres, the interstellar medium and extragalactic sources. The Space Telescope (ST) will not be sensitive to these short wavelengths because of problems involved in producing and maintaining a large optical system with the interference coatings necessary to render it efficient in the extended ultraviolet. The FUSE approach is to build a modest sized telescope with easier technical problems and with instrumentation that is optimized specifically for this spectral region.

W84-70685 **689-10-00**
Goddard Space Flight Center, Greenbelt, Md.
X-RAY TIMING EXPLORER (XTE)
William Hibbard 301-344-5712

The objective of this RTOP is to develop the technical and scientific basis for an X-ray Timing Mission to be proposed for flight in FY-89. The Explorer class mission will observe X-ray sources with instruments having high temporal resolution to complement X-ray data from HEAO and the planned Advanced X-ray Astrophysics Facility (AXAF) programs. The approach is to generate a preliminary system design based upon the three flight instruments that were selected by Announcement of Opportunity (AO) process. A project plan will be produced using the preliminary system design as a basis for determining the program and resources requirements. System definition will be initiated to optimize the design and to prepare for execution phase procurement. The approach assumes that the XTE will be a U.S. mission. A new start is presumed in fiscal year 1985.

Materials Experiment Operations

W84-70686 **694-01-00**
Marshall Space Flight Center, Huntsville, Ala.
MPS SCIENCE AND EXPERIMENT SUPPORT
J. R. Williams 205-453-1872

The objective of this RTOP is to conduct research on approved flight experiments. Research activities of principal investigators for approved flight experiments are funded to (1) conduct appropriate ground-based research; (2) prepare and test flight samples; (3) perform data analysis for both ground-based and flight samples; and (4) report results to NASA and the scientific community.

W84-70687 **694-01-01**
Lyndon B. Johnson Space Center, Houston, Tex.
BIOPROCESSING HARDWARE DEVELOPMENT AND INVESTIGATOR'S SUPPORT
Dennis R. Morrison 713-483-5281
(179-13-72)

The objectives are to provide support for co-investigators involved in flight experiments to enhance the capabilities of the Bioprocessing Laboratory in order to insure the success of bioprocessing research undertaken in support of the Materials Processing in Space Program; and to develop flight hardware necessary to carry out demonstrations of scientific or technical advantages of bioprocessing in space environments. In order to properly conduct feasibility studies and space flight experiments to determine the beneficial uses of microgravity in the production and purification of pharmaceutical type biological products it is necessary to obtain the support from the university and medical research community. By contractual agreement with investigators at various institutions, required support has been obtained for cell culture and cell separations techniques. Additional support will be sought in areas of commerical type cell culture systems and other related technology required to carry out definitive flight tests of bioprocessing methods in space. University laboratories specializing in biophysics, cell culture, bioassays methods and electrokinetic phenomena have been contracted to support bioprocessing tests n STS-3, 7, 8 and future flight opportunities.

W84-70688 **694-03-03**
Jet Propulsion Laboratory, Pasadena, Calif.
ACOUSTIC CONTAINERLESS EXPERIMENT SYSTEMS
D. J. Kerrisk 213-354-2566

The objective of this RTOP is to develop the technology for high temperature, containerless processing of materials in space, using acoustically derived forces for sample positioning and manipulation. While the theory and practice of acoustic levitation and manipulation has been well demonstrated at ambient temperature, the introduction of temperature gradients between the acoustic drivers and the resonant chamber raises questions that need to be investigated experimentally in a microgravity environment. Consequently, flight experiments have been planned to derive the necessary engineering data, as well as to perform initial scientific investigations on materials contained and manipulated acoustically. An experiment, designated ACES-MFD (Acoustic Containerless Experiment System - MidFlight-Deck), has been designed and built during FY's 82 and 83. It is presently undergoing system test. The experiment will be delivered to KSC early in FY-84 for installation on STS-11, currently scheduled for flight January 31, 1984. The data derived from this flight will be analyzed, and will form the basis for design modifications to the ACES-MFD for future flights, and for the design of future, more capable acoustic levitation facilities. Concurrently, the existing hardware from an earlier sounding rocket experiment (SPAR 77-18) will be modified and up dated as an experiment package for the MSFC developed Materials Experiment Assembly (MEA). This facility will allow investigations of acoustic manipulation of high viscosity fluids, providing important data for future experiment design.

W84-70689 **694-04-00**
Marshall Space Flight Center, Huntsville, Ala.
MPS GROUND-BASED TESTING/GROUND CONTROL EXPERIMENT LABORATORY
J. R. Williams 205-453-1872

The objective of this RTOP is to conduct the necessary ground-based development testing and ground control experiments to support the approved flight activities. The flight of each experiment sample requires that development tests be conducted to assure the experiment apparatus properly processes the sample and that ground control experiments, where applicable, be conducted for the 1-g vs. 0-g comparison. Flight-type samples will be tested and processed in flight apparatus against the experiment profiles planned for the space flight experiment runs.

W84-70690 **694-05-00**
Marshall Space Flight Center, Huntsville, Ala.
MPS FLIGHT EXPERIMENT APPARATUS
J. R. Williams 205-453-1872

The objective of this RTOP is to develop and maintain the experiment apparatus necessary to accommodate approved flight experiments. In order to accommodate approved flight experiments, experiment apparatus must be developed and/or modified and refurbished. Experiment apparatus will be produced that satisfies

a given set of experiment requirements. As a rule, each piece of experiment apparatus will be self-controlled in order to minimize integration on a carrier of opportunity.

W84-70691 **694-07-00**
Marshall Space Flight Center, Huntsville, Ala.
MPS EXPERIMENT DEVELOPMENT
J. R. Williams 205-453-1872

The objectives of this RTOP are to (1) provide experiment necessary to fly experiment apparatus on opportunity carriers; and (2) provide experiment apparatus for the MSFC drop tower and aircraft flights. In order to fly MPS experiment apparatus on various carriers in the orbiter cargo bay, equipment such as experiment apparatus containers (EAC's), power cables, command/data cables, fluid lines, etc., will be developed for each piece of flight apparatus. In addition, requirements are evolving for apparatus to drop in the drop tower and fly in the KC-135 and F-104 aircraft.

Sounding Rocket -- Solar Terrestrial

W84-70692 **828-11-36**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS: SPACE PLASMA PHYSICS EXPERIMENTS
James P. Heppner 301-344-8797

The objective is to perform measurements and experiments that will lead to an understanding of the interactive processes that occur between neutral gases, plasmas, energetic particles, and electric fields in the atmosphere, ionosphere, and near earth magnetosphere. Emphasis is placed on measurements and experiments that utilize the unique characteristics of sounding rocket trajectories and/or the low cost, quick reaction sounding rocket approach which permits program flexibility. Historically, this approach has logically been extended to include: (1) piggyback experiments on orbiting vehicles, (2) experiments involving sounding rocket flights in association with simultaneous satellite measurements in selected geometrical coincidence between trajectories, (3) flight testing of new instrumentation and measurement techniques, (4) shuttle flights of low cost, rocket type payloads, and (5) investigations of the electrodynamics of middle atmosphere (i.e., below 90 Km) using sounding rockets for deploying payloads which descend via parachutes.

Sounding Rockets

W84-70693 **879-11-38**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS
W. M. Neupert 301-344-5523

The sounding rocket program provides unique capabilities to conduct a broad range of scientific investigations. The program is particularly important for the development and demonstration of the merit of new instruments for shuttle flights and of prototype instruments for satellites. Furthermore, the short lead time and program flexibility make it possible to follow up new discoveries and to study particular phenomena on the Sun and in the Earth's atmosphere. Extreme Ultraviolet Spectra (EUV) of the Sun are a valuable tool for determining the true physical conditions in the solar corona. The main objectives are the determination of the flow of matter and energy from one region to another in the corona. For this purpose we need to know the coronal density, temperature, gas velocity, and radiation field. The work under this task is directed toward the development and flight on rockets of instruments for determining these four physical parameters in the corona. A better determination of the characteristics of the solar corona is necessary in order to discover the pradixical reasons why a coronal gas temperature of more than one million degrees can be maintained by energy from a region whose temperature is only five thousand degrees. These measurements are also important for determining the origin of the solar wind, which may arise from regions of open magnetic field.

W84-70694 **879-11-41**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS EXPERIMENTS (ASTRONOMY)
A. M. Smith 301-344-8718

The astronomical sounding rocket program provides a unique capability to conduct a broad range of scientific investigations. The program flexibility and short lead time make it possible to observe unusual physical phenomena for which satellite instrumentation is not available. The program flexibility makes it possible to expeditiously follow up discoveries as well as to provide tests and calibrations of satellite instrumentation. This unique capability is exploited by obtaining one of a kind observations of those types of astronomical phenomena that do not need large amounts of repetitive data to delineate their physical processes. New types of observations are possible because of recent technical advances in such essential areas as aberration control diffraction gratings and two dimensional multipixel photon detectors. These observations can contribute significantly to the understanding of the i.s. medium, stars, nebulae, and peculiar galaxies. The present objectives are to develop payloads which take advantage of opportunities to obtain spatial images of faint extended ultraviolet sources. Over the next few years, the present payload will be upgraded by employing improved detectors; a new payload will be designed to obtain very narrow band ($<$ 1nm) imagery. The latter instrument is intended to obtain information about line emission in external galaxies as well as galactic sources. All instrument development will be done in such a manner that the instruments can be used on Spacelab or on SPARTAN (Shuttle Pointed Autonomous Research Tool for Astronomy).

W84-70695 **879-11-46**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS (HIGH ENERGY ASTROPHYSICS)
E. A. Boldt 301-344-5853

High energy astrophysics (especially X-ray astronomy) is a rapidly evolving field of research, both scientifically and technically. Our exploitation of the capabilities of short lead time, planning flexibility, accurate pointing and extremely high telemetry rates afforded by rocketborne experiments are major factors in our success to date; a vigorous elaboration of this activity is now necessary for continuing to make timely and important contributions that complement data from our satellite missions and for the effective planning of advanced future missions (e.g., BEXRT, AXAF). This involves experiments with systems incorporating newly developed spectrometers and X-ray concentrators.

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

Advanced Systems

W84-70696 **310-10-23**
Goddard Space Flight Center, Greenbelt, Md.
SOFTWARE ENGINEERING TECHNOLOGY
Frank E. McGarry 301-344-5048
(506-54-56; 310-40-49; 310-10-26)

The objective of this RTOP is to identify, evaluate, and refine software engineering technology as applied to the software development process for the NASA environment. The technology to be studied includes development methodologies (such as structured implementation techniques, testing approaches, and structured analysis approaches to design), software development tools (such as code auditors and analyzers, configuration management aids and structured preprocessors), and software models (such as resource estimation models or reliability estimation models). The identified methodologies are intended to significantly reduce the overall life cycle costs of the software within the mission and data operations area. The approach to attain the stated

objectives includes the establishment of a software engineering laboratory (SEL) environment through which the identified areas of software technology can be investigated, measured, and refined under suitable conditions. The laboratory will support the research effort in the area of software methodologies, models and development tools. Within the SEL, candidate technologies will be identified, appropriate measures to be used in the evaluation process will be developed, detailed data will be collected during the development process, and the experiments will be conducted where the candidate methodologies will be applied to software development and maintenance tasks. This RTOP will support mission support computing as well as mission operations.

W84-70697 **310-10-26**
Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE/ORBIT TECHNOLOGY
Charles R. Newman 301-344-5666
(506-61-60; 312-80-53; 310-40-46)

The objective is to develop, evaluate, and demonstrate new technology for attitude and orbit determination/prediction/analysis for both ground-based and onboard application, including algorithms techniques, software, and hardware. The technology developed under this RTOP supports the Space Tracking and Data System in the areas of mission computing and analysis, TDRSS operations, and data processing. Alternate user tracking techniques will be identified and evaluated for accuracy of the orbit determination and the impacts on the ground and space systems of TDAS. Techniques that allow onboard navigation and that simplify ground based orbit determination will be examined. Various techniques, algorithms, and filters will be developed and evaluated for their applicability to automated and improved orbit and attitude determination and control configurations. The configurations may be onboard or ground-based. Various ground control point (GCP) processing algorithms will be analyzed and automated techniques for GCP registration will be designed.

W84-70698 **310-10-42**
Goddard Space Flight Center, Greenbelt, Md.
PRECISION TIME AND FREQUENCY SOURCES
S. Clark Wardrip 301-344-6587
(644-03-05; 676-59-35)

The objectives of the RTOP are to improve existing hydrogen maser frequency standards, develop improved frequency and time standards, and to develop associated time and frequency distribution and measurement systems for VLBI near Earth and Deep Space Tracking, Tracking Data Relay System (TDRS) and other NASA programs requiring precision time and frequency devices. The development of improved NR maser designs will continue. Major laboratory studies planned include the continued evaluation of the quartz cavity liner; the initial evaluation of the integral cavity; and the continued development of the SCO for interfacing with the NR maser. Continued evaluation of the NR masers operating in the field will also provide inputs to improvements in reliability and serviceability. Initial evaluation of the variable volume hydrogen maser will begin. This maser has potential as a frequency and calibration standard for 1 x 10 - 14 frequency accuracy. Processing and fabrication technology for the manufacture of electrodeless quartz supported resonators will begin development. These resonators have improved short term and long term aging characteristics. Measurement systems and techniques will be developed for evaluating an ensemble of interacting masers for improved frequency and time keeping and dissemination, using a new automated measurement system.

W84-70699 **310-10-60**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO METRIC TECHNOLOGY DEVELOPMENT
Karen S. Wallace 213-354-4552
(310-10-62; 310-10-63; 310-10-61)

The broad objective of this RTOP is the development of advanced radio metric systems used by the DSN for spacecraft navigation and radio science. This objective is pursued in 3 ways: (1) by the demonstration of the current accuracy capabilities of 'in-hand' technology that will meet the short term requirement of 50 nanorad (nrad) navigation accuracy, (2) by investigation and reduction of the error sources that limit this present capability in anticipation of future accuracy requirements of 5 nrad, and (3) development of specialized technologies with high potential for application to next generation tracking techniques. The approach in this RTOP is to utilize Very Long Baseline Interferometry (VLBI) techniques which measure the angular separation of a spacecraft and a nearby extragalactic radio source (EGRS). This technique relies on differencing the interferometric measurements (Delta VLBI), which results in a high degree of common mode error cancellation, thereby yielding highly accurate EGRS-relative positions and cross-track velocity determinations. This approach yields the following specific objectives: (1) the demonstration of narrowband (NB) Delta VLBI determinations of the cross-velocity of planetary orbiters to an accuracy of 5 picorad/second (prad/sec), (2) the investigation of the limiting error souurces for wide 'spanned bandwidth' Delta VLBI (termed Delta Differential One-Way Ranging, or Delta DOR) through differential observations of natural sources, (3) the determination of the offset between the EGRS and planetary reference frames, (4) the development of improved methods for the calibration of media propagation effects on radio metric data, and (5) the development of modelling and instrumentation capable of supporting 5 nrad VLBI measurements.

W84-70700 **310-10-61**
Jet Propulsion Laboratory, Pasadena, Calif.
EARTH ORBITER TRACKING SYSTEM DEVELOPMENT
T. P. Yunck 213-354-3369
(310-10-60; 310-10-63)

The objective of this RTOP is to develop an integrated system for tracking Earth satellites from low Earth orbiters (LEO's) to highly elliptical orbiters (HEO's) to geosynchronous orbiters (GEO's). The system should improve on current tracking accuracy by an order of magnitude yet it should be inexpensive to deploy and operate. Nominally, it should provide satellite position accuracies of a meter or better below 600 km altitude, a few decimeters between 600 km and about 5000 km scaling up to 1 to 5 meters at geosynchronous altitude. It should require no more than a dozen ground terminals (as few as four for some applications) and those should be transportable, operate unattended, accumulate data at phone line compatible data rates, and cost less than $1 million a piece. Finally, the system should be able to determine its own station locations at the decimeter level, provide continuous coverage for an unlimited number of orbiters, and operate in a purely passive or receive-only mode. The approach is to adapt differential Very Long Baseline Interferometry (delta VLBI) to the high altitudes and apply the SERIES-X doubly differenced GPS data types (which are simple variations on delta VLBI) to the low and intermediate altitudes. Fundamental similarities between the two techniques allow the VLBI and SERIES-X capabilities to be integrated into a single compact receiver. Deep space delta VLBI employs quasars for position reference; in the adaptation to Earth satellites, reference will be transferred to the Navstar satellites of the Global Positioning System (GPS) This can be done because SERIES-X will continuously provide Navstar orbits to better than one meter. Both Delta VLBI and SERIES-X will observe only satellite signals and extract phase from those signals for later differencing. Special clock synchronization observations of the Navstars will be made when VLBI is applied to a satellite transmitting at a frequency different from that of GPS. Procedures for such clock synchronization will be developed.

W84-70701 **310-10-62**
Jet Propulsion Laboratory, Pasadena, Calif.
FREQUENCY AND TIMING RESEARCH
R. L. Sydnor 213-354-2763
(310-10-60; 310-10-61; 310-10-64; 310-10-68)

The thrust of this RTOP is the development of frequency and time standards, distribution systems and equipment for the effective utilization of these technologies in the DSN of the next decade. Accurate and stable frequency and time are the basis for outer space navigation, particularly for VLBI techniques. The reliability

of these systems must be improved in order to decrease M&O costs and to increase the H-maser availability to 99.9%. The goal is to improve the mean time between failures from 25 months to 5 years and the mean time for repair from 3 months to 3 weeks. In addition, the present frequency and timing performance of the DSN of 10 to the -14th power and 100 nsec must be improved by the mid-1980's to 3x10 to the -16th power and 10 nsec. The goal for the early 1990's is 10 to the -17th power and 1 nsec. New technology, such as trapped ion, superconducting cavities or cooled quartz oscillators, must be developed to meet these goals. Redundant frequency standards are planned to achieve the high system reliability, so a means must be provided in the form of a Frequency Standard Selection and Control System (FSSCS) to achieve switching to alternate standards upon failure of the prime standard with a minimum change of frequency and phase. The goal is 0.01 degrees of phase and 10 to -15th power change in frequency (delta f/f). Effective utilization of the high stabilities achieved by the frequency standards requires precision frequency and time distribution. Fiber optic systems will be developed to disseminate these references over distance from 10 meters to 30 kilometers. The goal of the fiber optic system is 10 to -18th power frequency stability and 0.1 nsec time stability.

W84-70702 **310-10-63**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE SYSTEMS AND NAVIGATION TECHNOLOGY
J. Ellis 213-354-2788
(310-10-60; 310-10-61)

The basic objective of this RTOP is to establish the anticipated navigation requirements for DSN supported deep space missions planned for the 1985-2000 era and to assess their implications on the DSN radio metric system. Drivers for future development are the stringent navigation accuracies anticipated for outer planet and for planetary orbiter missions and the need for navigation concepts to enable support of low cost Mariner Mark II and Pioneer missions. To meet the future navigation needs the RTOP focuses on three primary areas. The first, navigation technology, identifies and evaluates data strategies for improving deep space navigation accuracies, and enhancing mission capabilities. Radio metric data requirements for new navigation functions, such as Asteroid and Comet orbiters, are established. Navigation concepts and data strategies, consistent with low cost mission support are formulated and demonstrated using data from current missions. Data strategies includes use of noncoherent data and delta VLBI capabilities and filtering techniques which reduce navigation sensitivity to critical measurement system error sources. The second area focuses on reducing mission operations costs and increasing reliability by the automation of radio metric data processing. A prototype multimission navigation data processing facility will be implemented and demonstrated on a dedicated VAX 11/780. This system will serve as the foundation for the long range goals which are to develop high speed computer graphics capabilities and initiate automated event driven operations and diagnostic procedures. The third program establishes system level requirements for an Earth orbiting antenna to be used for acquisition of VLBI data for deep space navigation and radio science applications. Improved angular accuracies can be expected with the longer baselines formed by a high Earth orbiter and a ground antenna. Initial objectives are to demonstrate using TDRSS the feasibility of transferring ground based stable of frequency standards to an Earth orbiter and to obtain interferometric fringes using the TDRSS single access antenna and a DSN station.

W84-70703 **310-20-33**
Goddard Space Flight Center, Greenbelt, Md.
NETWORK SYSTEMS TECHNOLOGY DEVELOPMENT
J. Schwartz 301-344-7313

The objective of this RTOP is to investigate the applicability of new technology in the TDRSS era. Selected technology will be investigated by means of feasibility studies, prototype development and demonstration, and by cost and reliability impact studies. A major goal is to investigate the effect of non-gaussian channel characteristics on TDRSS link performance and develop coding and signal designs which optimize link performance. Associated with this goal is the objective of validating the analytical predictions by means of limited hardware simulations.

W84-70704 **310-20-38**
Goddard Space Flight Center, Greenbelt, Md.
SATELLITE COMMUNICATIONS TECHNOLOGY
D. D. Wilson 301-344-5257

The objective of this RTOP is to introduce efficient high-rate digital telecommunications transport systems to support NASA programs by 1986. The work focuses on two major tasks whose objectives are to define and demonstrate an efficient multinode satellite-based digital telecommunications system which can provide to geographically dispersed user multiple-access on a common link; and to define and demonstrate advanced signal processing and coding techniques which could provide an improvement in data transmission speed and performance through 36-MHz C-Band domestic satellite transponders. The system requirements and resultant network architecture will be defined. System elements will be developed and demonstrated including low-cost implementation of time division multiple-access (TDMA) terminals, maintenance and control terminal, network control center, digital speech interpolation terminal, integrated voice and data switching terminal, and transportable satellite Earth station. The feasibility of combining the best performance of signal processing and coding elements will be evaluated using modeling and computer simulation techniques to provide 85 MBS transmission through a C-band transponder at 1x10 to the -7th power bit error rate and 99.5% error free seconds with specified satellite system characteristics.

W84-70705 **310-20-39**
Goddard Space Flight Center, Greenbelt, Md.
VERY LONG BASELINE INTERFEROMETRY (VLBI) TRACKING OF THE TRACKING AND DATA RELAY SATELLITE (TDRS)
Philip E. Liebrecht 301-344-7782

The objectives of this RTOP are to utilize VLBI Tracking of the TDRS's as an independent measure with which to validate the TDRSS Tracking capability, to demonstrate the application of passive VLBI techniques to improve TDRS trajectory determination, and determine the detailed requirements and specifications for an operational, dedicated, TDRS VLBI system. A three-phased approach will be used. During the first phase, an experiment will be conducted to demonstrate the feasibility of the technique, and provide data for evaluation of different design alternatives, and comparison with the Bilateration Ranging Transponder (BRTS) derived orbits. The second phase will involve formulating overall functional requirements and system analysis for a dedicated operational system leading toward the final phase which will develop complete detail system specifications for such a system.

W84-70706 **310-20-46**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED SPACE SYSTEMS FOR USERS OF NASA NETWORKS
R. P. Hockensmith 301-344-9067
(506-61-26)

The objective of the work under this RTOP is to achieve technological advances in radio frequency (RF) systems, antenna systems and associated control technology, on-board data storage systems and in telecommunications coding. These developments will satisfy future requirements of Users of NASA networks (spacecraft and space transportation system payloads) that require near-global coverage through data relay satellite systems (Tracking and Data Relay Satellite System (TDRSS); Tracking and Data Acquisition System (TDAS)) and other networks as appropriate for the support of the missions. The approaches for accomplishing the objective are to: (1) identify the basic operational space flight requirements; (2) investigate RF active and passive components and antenna systems that are feasible, but may be a technical risk, to attain the required RF performance; (3) investigate methods of reducing and controlling torque noise induced into space platforms due to electro-mechanical steering of large high gain antennas; (4) investigate methods of high density

and high rate recording and storage; (5) investigate improvements in telecommunication coding schemes for spacecraft generated data; (6) develop system designs incorporating these optimum subsystem to permit User projects to specify proven, reliable hardware with a high confidence level in the performance capability, cost and required procurement cycle; and (7) exploit necessary improvements in testing techniques that properly characterize these critical systems.

W84-70707 **310-20-64**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED TRANSMITTER SYSTEMS DEVELOPMENT
Rob Hartop 213-354-3433
(310-20-65; 310-30-68; 310-30-70)

The objective of this RTOP is the development of Advanced Transmitter Systems applicable to future DSN missions that also provide the capability to perform radar astronomy on planets, satellites, asteroids, comets and other targets within the solar system. Currently nearing the completion of testing is a 20 KW transmitter system and receiver/exciter operating at 7.2 GHz at DSS-13. This transmitter will demonstrate the capability for reliable high power wide band (100 MHz) operation with 1000 second frequency stabilities of 5 parts in 10 to the 15th power and fully automated control and monitoring. Extension of the automation technology to the two superpower transmitters at DSS-14 will increase their reliability and availability for planetery radar and emergency spacecraft support. A thrust beginning in FY-84 is to study and begin development of the technology for a Ka-band transmitter that will build upon and extend the techniques demonstrated by the present transmitters at S- and X-bands. Specific FY-84 objectives include: (1) completion of all tests of the new 20 KW X-band uplink system at DSS-13; (2) experiments to determine the extent of interference during simultaneous S- and X-band transmission and analysis to determine corrective methods; (3) study of the available technology, required developments, and benefits to the DSN and planetary radar of a K-band transmitter; and (4) continued support for superpower planetary radar by maintenance and operation of the DSS-14 R&D transmitters. Long term objectives include the development of new superpower waveguide techniques including methods of reliably combining two or more 100 to 250 KW sources, improved phase stability in transmitters, more intelligent monitor and control systems, and new filters for advanced transmitter systems.

W84-70708 **310-20-65**
Jet Propulsion Laboratory, Pasadena, Calif.
ANTENNA SYSTEMS DEVELOPMENT
D. Bathker 213-354-3436

The objective of this RTOP is to identify, develop, and utilize selected applicable technology related to large Earth antennas for deep space communications, radio and radar science for the 1985 to 1995 time frame. The technology development effort aims at enabling the optimum use of existing facilities through affordable modifications and the construction of new facilities with maximized performance and minimized capital and life-cycle costs. The two-prong approach via mechanical and electromagnetic modifications includes: (1) software-intensive analytic scattering studies for RF performance prediction; (2) study and trial reflector and feed designs carried through concept development and demonstration; (3) development and field demonstrations of advanced multiband feeds; (4) software-intensive analytical multiple constraint structural optimization for efficient designs of large, precise antenna structures and servomechanisms; (5) investigation of techniques and processes to enable affordable fabrication and use of precise main- and sub-reflector surfaces; and (6) study and trial designs to accomplish affordable 64- or 70-meter antenna performance upgrades. Earlier work has identified 1.9 dB of added antenna gain as available by selected modifications to the basic 64-meter DSN systems at X-band. Additional work concentrates on further enhancements to the 64-meter antenna to enable additional figure of merit (antenna gain vs. system temperature) improvements at X-band and provides versatility for operation across the 1.50 GHz range. A planned new research and development antenna at the Venus site to replace DSS 13 will utilize advanced concepts for improved system stability, super power (near 400 KW) transmitter demonstration at 34 GHz, and the field tests of multi-frequency systems covering selected bands in the 1-50 GHz range.

W84-70709 **310-20-67**
Jet Propulsion Laboratory, Pasadena, Calif.
OPTICAL COMMUNICATIONS TECHNOLOGY DEVELOPMENT
J. R. Lesh 213-354-2766

The objective of this RTOP is to develop and demonstrate the technology needed for efficient and reliable optical communications for DSN supported missions in the 1990's and beyond. To accomplish this objective, and to focus the RTOP, a near term goal of demonstrating a 4 Mbps optical link from a space-borne mission by the end of FY-88 has been established. The actual building, and integrating of the flight hardware, as well as the performing of the demonstration are assumed to be funded outside this RTOP. However, this RTOP will develop the critical technologies which, through a logical series of engineering tests, will lead to an engineering model for the proposed space-borne demonstration system. Specifically, this RTOP will investigate signal design, modulation and detection techniques which are compatible with hardware constraints and which make the most efficient use of the available optical signal power. These techniques will be integrated with companion technologies such as pointing and tracking systems, telescope systems and synchronization systems to assure their mutual compatibility. Additionally, key optical signal source technologies will be developed with particular attention given to semiconductor laser array and modulated solid state laser systems. In support of the longer term objective, this RTOP will develop and demonstrate laser source and laser detection technology for both noisy (high background light) environments typical of missions near brightly lighted planets, as well as the more benign (darker) environments characteristic of planetary encounters far from the Sun. This technology is expected to utilize heterodyne reception techniques for the former and direct detection techniques for the latter.

W84-70710 **310-20-68**
Jet Propulsion Laboratory, Pasadena, Calif.
DSN MONITOR AND CONTROL TECHNOLOGY
C. Foster 213-354-5070

The objectives of this RTOP are the development and demonstration of technology for unattended tracking station operations, and the generation of a data base for assessment of the impact of unattended operations on network productivity and network life-cycle costs. The approach used is the development of a test bed remote controlled unattended station at DSS 13. This test bed includes automated control of an unattended 26-M antenna, high power transmitter, receiver-exciter, and data processing subsystems (subcarrier demodulator). Control of the equipment is from JPL. This test bed has evolved over several years to include an increasingly comprehensive set of subsystems, and improved operator interfaces. Fully unattended receive capability was demonstrated for six months in FY's-78 and 79 to provide controlled life-cycle cost data. Unattended operation of the high power transmitter was demonstrated for two months in FY-80 to 81. An unattended uplink demonstration of tracking and commanding the Pioneer Eight spacecraft begins in FY-83 and extends into FY-84. The emphasis in FY-84 will be: (1) to implement and collect and engineering data base of the multi-frequency upconverter maser and cryogenic cooling equipment; (2) operate DSS-13 in an unattended mode to collect reliability data base and provide engineering inputs to future DSN implementation on unattended tracking and command operations; (3) develop design and automate routine manpower intensive functions of NOCC to provide fully integrated end-to-end DSN demonstration; and (4) provide a comprehensive technical report on overall unattended station development.

W84-70711 **310-20-71**
Jet Propulsion Laboratory, Pasadena, Calif.
COMMUNICATIONS SYSTEMS RESEARCH
J. H. Yuen 213-354-7058
(310-20-67)

The objective of this RTOP is to develop communication systems technology required to meet the needs of DSN supported missions for the late 1980's and 1990's. To meet the foreseen needs for efficient and low cost NASA space communications the RTOP will focus on improving or expanding microwave communication capability. The work planned will involve four areas: (1) The threshold of the current DSN telemetry system will be decreased by at least 1.5 dB through reductions in parasitic degradations which prevent DSN from achieving its theoretically designed performance. Losses must be identified, understood, and eliminated in order to improve end-to-end performance. The work will model and computer simulate subsystems to estimate individual subsystem impact on the quality of delivered data. The subsystems which will be examined include the receiver, subcarrier demodulator assembly, symbol synchronizer assembly, Viterbi decoder, and Reed-Solomon decoder in the near term, and the Ground Communications Facility in the far term; (2) Coding/decoding and modulation/demodulation techniques which are consistent with the present day constraints on complexity will be investigated in order to achieve an additional 2.0 dB reduction in required signal to noise ratio. This objective will be met by designing, analyzing and comparing state-of-the-art coding systems and coding systems used in conjunction with cooperative channel modulation, and by decoding schemes of higher complexity enabled by new VLSI technology; (3) Communication efficiency will be improved by developing information processing methods which can maintain information content but reduce required data volume and rate; (4) Techniques to assure robust communications under non-ideal channel environments will be developed. In particular, methods of avoiding or overcoming weather loss and radio-frequency-interferences will be investigated.

W84-70712 **310-22-66**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO SYSTEMS DEVELOPMENT
J. A. McNeil 213-354-3268

The objectives of this RTOP are to improve the Earth-based receiving elements of the spacecraft-to-Earth communicatons link to meet the future navigation, telemetry and science needs of the DSN; to lower the cost of implemenation and modification and provide for unattended operation through appropriate digital technology; and to increase the reliability and decrease the cost of maintenance of receiving equipment and cryogenic systems. Seven approaches are being made: (1) develop a multifrequency, ultralow noise amplifier to cover S-, X- and Ka-bands with broad bandwidths and high frequency stability; (2) develop the analytical skills and tools to improve the performance of existing X- and Ka-band masers and to design and build ultralow noise wideband parametric upconverters; (3) develop cryogenic filters for low noise amplifier protection from radio frequency interference; (4) improve the reliability and performance of the cryogenic cooling equipment by tripling the MTBF and doubling the cooling efficiency over present 1 watt systems in the DSN; (5) develop a Joule-Thomson valve cryogenic pressure regulator in order to provide a more constant pressure/temperature characteristic for the 4 Kelvin stage of the closed cycle refrigerator; (6) develop a receiver system using digital techniques to achieve the versatility, stability, and unattended operation compatible with the future needs of the DSN at a minimum life cycle cost; (7) calibrate and model the propagation medium and establish a database of the statistics of meteorological effects at X- and Ka-bands. Use measured data and analytical studies to determine system performance degradation caused by rain collecting on the antenna surface and feed system components.

W84-70713 **310-30-70**
Jet Propulsion Laboratory, Pasadena, Calif.
DIGITAL SIGNAL PROCESSING
W. J. Hurd 213-354-2748

The purpose of this RTOP is to investigate, develop, test and demonstrate advanced signal processing techniques and equipment which enable the DSN to plan and achieve its performance requirements at reduced risk and cost to implementation and operations. A major new thrust is the development of advanced receiver signal processing for the DSN which will enhance the antenna arraying capability at Voyager Uranus and Neptune encounters. The current engineering objectives are: (1) to design, develop and demonstrate high performance, miniaturized and cost effective digital signal processing for the telemetry signal processing portions of a portable advanced receiver for the DSN; (2) to develop digital signal processing suitable for low signal-to-noise ratio antenna arraying at the detected telemetry symbol level, and to demonstrate the performance and cost effectiveness of this technique by symbol stream combining of Voyager signals at Uranus encounter; (3) to develop and demonstrate custom high speed very large scale integrated circuits (VLSI) to meet DSN peculiar needs including reduced cost in high performance coders and decorders; and (4) to characterize the RFI environment at Goldstone, providing support to the NCP effort. During FY-84 the tasks are: (1) develop portions of the advanced receiver signal processing sufficient to process Voyager telemetry signals; (2) develop hardware and software to demonstrate symbol stream combining of Voyager signals for a two station demonstration in early FY-85 using the advanced receiver above and one standard DSN receiving channel; (3) demonstrate the ability to develop high performance customized circuits in a cost effective manner by designing, fabricating and testing a 4-bit Reed-Solomon decoder chip and designing an 8-bit Reed-Solomon decoder chip; (4) specify and support development under RTOP 72 of one or two signal processing VLSI chips for use in the advanced receiver; and (5) support use of the RFI trailer in characterization of RFI environment at Goldstone.

W84-70714 **310-40-26**
Goddard Space Flight Center, Greenbelt, Md.
OPERATIONS SUPPORT COMPUTING TECHNOLOGY
D. T. Ketterer 301-344-8460

This RTOP is aimed at improving the accuracy, timeliness, cost-effectiveness, and operational aspects of ground-based orbit computations and products in the TDRSS era. It addresses the evolution of the Operations Support Computing (OSC) technology; the objective is to research, analyze, and develop advanced operational concepts, and computer system designs for operations. System studies in FY-84 will concentrate on developing concepts and techniques for an intelligent terminal based system to improve the OSC functions. The Research and Technology Support Facility employing intelligent terminals will be used to develop and demonstrate recommended operations concepts. Other tasks will focus on the study of human factors engineering aspects for the Network Control Center operations and improving computer printout speeds while reducing costs.

W84-70715 **310-40-37**
Goddard Space Flight Center, Greenbelt, Md.
HUMAN-TO-MACHINE INTERFACE TECHNOLOGY
W. F. Truszkowski 301-344-9261

The objectives of this RTOP are to: (1) develop and apply 'natural' man/machine interfaces for space payload and ground control systems including data base management systems; and (2) develop methodologies, models, and guidelines which emphasize the human factors issues associated with man/machine interfaces and interactions. The intention is to apply recent advances in human factors analysis, data base management, and artificial intelligence (AI) to man/machine interface and interaction problems. The approach to be taken is: first, to identify and apply state-of-the-art data base management technology to mission and data operations systems; second, to apply human factors and advanced knowledge engineering techniques and methodologies

in the development and application of user interfaces to various data/information systems actively used in the mission and data operations environment; and third, to formulate and execute a plan for a human factors testbed to support near term application-directed man/machine interface development and analysis. This RTOP is a system level RTOP supporting TDRSS operations, mission operations, mission support computing, and general systems engineering activities.

W84-70716 **310-40-45**
Goddard Space Flight Center, Greenbelt, Md.
MISSION OPERATIONS TECHNOLOGY
P. J. Ondrus 301-344-8001

The main objective of this Research and Technology Objectives and Plans (RTOP) is to develop techniques and validate concepts that will improve operations efficiency, reliability, and reduce mission cost. The RTOP approach consists of supporting four separate, but interrelated tasks. The first task, the Control Center Automation Task, seeks to study and specify levels of automation for systems resource allocation, connection, test and status reporting. This task also involves the demonstration of a display system applicable to data presentation and resource allocation in a command and control environment. The second task, Distributed Command and Control, seeks to develop and implement a distributed command and control system concept applicable to attached payloads. Special emphasis will be placed upon user interfaces. The third task, System Implementation Tools, will provide an assessment of the software tools needed to efficiently implement systems in a command and control environment and seek to develop and demonstrate prototype tools. The fourth task, Optimization of Distributed Systems, will provide computer models that allow for the analysis and optimization of computer networks. This RTOP is a system level activity supporting mission operations.

W84-70717 **310-40-46**
Goddard Space Flight Center, Greenbelt, Md.
DATA PROCESSING TECHNOLOGY
Frederick W. McCaleb 301-344-6386

This RTOP supports the development and utilization of new technology to improve the performance of high data volume data processing systems. Currently there are two major objectives: (1) utilization of optical disk digital data storage technology in data processing systems; and (2) development of guidelines for automatic error management in high volume data processing systems. These objectives are being pursued as two independent tasks. Task one consists of two elements: (1) implementation of a digital optical disk test bed system; and (2) development of data management strategies for large data bases stored on optical disk. Task two assesses various error management and quality control techniques to determine an economically viable level of automatic error management in high data volume data processing systems.

W84-70718 **310-40-49**
Goddard Space Flight Center, Greenbelt, Md.
SYSTEMS ENGINEERING AND MANAGEMENT TECHNOLOGY
Robert W. Nelson 301-344-7809

The objective of this RTOP is to develop and evaluate systems-level concepts and technologies which will be utilized to optimize the management, operation, and evolution of the Space Tracking and Data Systems (STDS). Major subobjectives are: (1) the development of a systems engineering and management support system for the introduction and consistent use of systems engineering principles and management practices in all phases of the system life cycle; (2) the definition, designing, and implementation of a cost/allocation/prediction model for STDS subsystems; and (3) the development of an interactive model and decision support system which characterizes information and decisions utilized by software managers. The RTOP approach is to develop associated tools and techniques, apply the techniques to representative problems, and evaluate both the techniques and the results prior to full utilization in STDS. This is a system level RTOP supporting mission operations, mission support computing, spacecraft data acquisition, data processing, and TDRSS operations.

W84-70719 **310-40-72**
Jet Propulsion Laboratory, Pasadena, Calif.
NETWORK HARDWARE AND SOFTWARE DEVELOPMENT TOOLS
W. M. Whitney 213-354-4410
(310-31-70)

The primary objective is to automate some of the functions of organizing, conducting, and managing the design and development of digital system hardware and software. The use of computers to handle the details of such complex processes will increase the productivity of design engineers and managers, improve the quality and reliability of their products, and reduce the costs of system development and maintenance. This work will yield: (1) methodology and tools for planning and conducting design, and for characterizing, evaluating, and documenting the design process and its products; (2) principles of organization and communication for integrating the tools and the resources of host computers into coherent systems; (3) prototype software and hardware (including very large scale integration (VLSI) chips) to demonstrate the effectiveness and validity of the methods and the tools. The approach includes specific objectives for FY-84: (1) assembling requirements for a standardized software environment that will make it possible to design target systems for the DSN from a variety of host machines, and to access software for tool building, program development, resource management and control, and documentation available and in use in other environments; (2) augmenting the VLSI design system now under development with tools to generate circuitry from high level specifications of circuit functions, and increasing its scope to include circuits built from gate arrays, standard cells or VLSI macrocells, integrated circuits, and other components; (3) completing the design and securing fabrication of a VLSI toggle register for generating binary sequences with prescribed properties at very high clock rates; (4) initiating the design of a custom VLSI accumulator for the advanced receiver, and studying the use of gallium-arsenide technology for this application in cooperation with RTOP 70. Work in progress on VLSI design algorithms, on VLSI design tools for circuit layout and simulation, and on tools for software development, documentation, characterization, and management will continue.

OFFICE OF SPACE FLIGHT

Advanced Programs

W84-70720 **906-31-00**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL PROPELLANT TRANSFER
W. S. Beckham, Jr. 713-483-3084

Propellant depletion is a common cause for the loss of service from satellites. This project is to develop and demonstrate the techniques for refueling satellites on-orbit, either in the cargo bay or remotely. The critical component in a refueling design is zero spill, multiple seal, quick disconnect coupling. This RTOP provides for the systems analysis and design to characterize the complete system and the coupling tasks for FY-84.

W84-70721 **906-54-00**
Lyndon B. Johnson Space Center, Houston, Tex.
CREW SYSTEMS (REGENERATIVE LIFE SUPPORT SUBSYSTEMS)
A. F. Behrend 713-483-4823

The use of expendables for long duration mission life support such as for a space station would be prohibitive in overall cost and extremely inconvenient and inefficient in operation. Consequently, the use of more expendable-free system designs will be required. To achieve this desired capability, the Environmental Control and Life Support System (ECLSS) design approach must evolve from the Orbiter baseline expendable 'open loop' design

to more 'closed loop' designs with reduced expendables. In addition, since these long duration capability systems will have to operate for longer periods than previous life support systems, particular consideration must be given to developing confidence in the selected processes and demonstrating the maturity of the various technologies. Without a comprehensive development program, the flight readiness of this long duration mission life support technology will not be accomplished in a timely manner. This RTOP is to continue the development and demonstration of the regenerative life support technology, emphasizing air revitalization and water management, necessary to permit extended duration missions.

W84-70722 **906-54-27**
Lyndon B. Johnson Space Center, Houston, Tex.
ONBOARD DATA SYSTEMS LONG LEAD TECHNOLOGY STUDIES
John R. Garman 713-483-3969
(906-80-11)

Avionics and especially embedded data systems design activities on new projects have traditionally started with a 'clean slate'. While this produced the maximum flexibility to manipulate constraints in the overall system design effort, it also caused the maximum 'front end' investments in order to produce any initial usable systems. As the Agency embarks on the planning and development of advanced and future flight systems, data systems and software will play an increasingly large role in the success and cost of any individual program or project. There is a specter of creating more and more unique systems (flight and ground) each with their own life cycle costs and human skills. The approach that this study takes involves examination of the current BASIC architecture of the Shuttle flight and support systems against the current consensus of requirements and operations concept for a manned space station. The study will attempt to establish a balance between the techniques and basic architectures of the shuttle systems and the current technology and direction of the space station involving both enhancements to the shuttle systems as well as a degree of compatibility or commonality among all future flight systems. This commonality, unlike standardization efforts of the past, must and will allow for technology upgrades while maintaining the maximum 'capture' of investments in software and techniques. The principal products are a software management plan and a set of system level prototype specifications on the flight and ground support data systems supporting this approach.

W84-70723 **906-54-28**
Lyndon B. Johnson Space Center, Houston, Tex.
CRYOGENIC PROPELLANT SCAVENGING STUDY ZERO-G SLUSH PRODUCTION AND STORAGE
W. Scott 713-483-3278

The objectives of this RTOP are to accomplish the following tasks: (1) define the characteristics of cryogenic transfer from an operational and utilization approach; (2) perform a flight design assessment of the ET propellant scavenging concept and identify incompatibilities and/or tradeoffs between requirements and operations; (3) assess long-term storage of cryogenic through tank design, slush production shadowing and other mechanisms as may be defined; and (4) evaluate the benefits and operational requirements for tethered storage tanks to include settling, storage times, cryo transfer and tether lengths. The approach to the first task will be parametric in nature. Low-g transfer will be studied to examine a correlation between thrust level, transfer rate, and timeline. Fluid properties will be assessed before, during and after transfer. The second task will be accomplished through the completion of the following analyses; ET disposal, ascent performance analysis, attitude analysis, mission capability, and flight software assessment. The third objective will incorporate data from the scavenging study and apply it to study transfer and storage time to tethered as well as hard docked tanks. The fourth objective will be to establish operational requirements for cryogenic storage systems in space. This will include properties system fluid losses, gauging requirements, etc.

W84-70724 **906-54-31**
Lyndon B. Johnson Space Center, Houston, Tex.
AUTOMATED RENDEZVOUS AND PROXIMITY OPERATIONS FLIIGHT DESIGN
R. W. Becker 713-483-5276

Future on-orbit operations will require routine, automated rendezvous and proximity operations to the space station and to satellites for servicing, docking, retrieval, maintenance, repair, or inspections. Many of these objects requiring services will be in orbits not attainable by the space shuttle. Work to date to develop automated rendezvous and proximity operations has resulted in the definitoin of automated operational techniques and the development of the orbital operations simulator. It is now possible to utilize this high fidelity simulator to influence the early design phase of proposed unmanned orbital vehicles such as the TMS or manned vehicles such as the MOTV. The simulator will be used in this task to develop and verify automated operational techniques and requirements, software requirements, free-flyer hardware configurations, sensor requirements, flight profiles, and command/control concepts. In addition to these tasks, the simulator can also be used to investigate tradeoffs relating to cost versus manual or automated control. Cost tradeoff issues include avionics integration and software verification costs, crew training and simulation, and realtime mission control center support.

W84-70725 **906-55-10**
Marshall Space Flight Center, Huntsville, Ala.
STRUCTURAL ASSEMBLY DEMONSTRATION EXPERIMENT (SADE)
J. K. Harrison 205-453-2769

The SADE objectives are as follows: to demonstrate that the shuttle is a suitable base for space construction; to determine the extent to which Neutral Buoyancy Simulator test results can predict flight test results, and to validate and demonstrate the SADE truss design by measuring the performance of the deployment and assembly operation. A single flight in 1985 is planned to construct a 50-foot long truss structure using both deployment and assembly techniques. The construction operation will require EVA and RMS activity. The entire construction procedure will be simulated in the MSFC Neutral Buoyancy Simulator before the flight. Hardware already developed will be modified for use in these simulations. Flight hardware configurations will be based on the results from these simulations.

W84-70726 **906-63-03**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL TRANSFER VEHICLE (OTV) SYSTEMS DEFINITION
D. R. Saxton 205-453-2817
(506-63-59; 506-63-29)

The objectives of this effort are to conduct conceptual definition and technology studies of OTV concepts, subsystems, evolutionary aproaches and implementation of an aeroassisted flight demonstration experiment. Particular emphasis will be placed on: (1) investigation of an alternative launch modes, basing options, missions; (2) establishing feasibility and providing definition/optimization of OTV concepts; (3) assessing and planning for development and verification of technology; (4) conducting cryogenic breadboard testing; and (5) definition of a flight experiment to demonstrate critical aspects of an aeroassisted OTV atmospheric mission phase. Phase A in-house and contracted studies have resulted in several selected ground based shuttle orbiter compatible OTV concepts, both aeroassisted and all-propulsive. The FY-83/84 activity will investigate concepts compatible with alternative launch and basing modes. The cryogenic breadboard is being installed in the thermal vacuum chamber facility and testing will be initiated. It is expected that OAST will assume funding of the aeroassist concept analysis task continuation. A flight experiment demonstration of the aeroassist OTV is included to provide for definition of the alternative approaches for an aeroassist demonstration mission.

W84-70727 **906-63-06**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED TRANSPORTATION
B. Roberts 713-483-4093

Proposed space missions for the 1980's and beyond require high performance orbital transfer vehicles capable of space basing, economical recovery and re-use, and manned operations. This RTOP addresses the requirements of high energy manned GEO and lunar missions, aerobraking OTV return, propellant scavenging for possible cost savings and potential applications of tether technology. The specific tasks for FY-84 are: OTV guidance and navigation requirements analysis; manned GEO and lunar systems analysis; space basing requirement analysis; tether technology for fluid transfer; tether technology for power motor; STS propellant scavenging; OTV aerobraking technology development; and OVT aerobraking guidance and navigtion.

W84-70728 **906-63-33**
Marshall Space Flight Center, Huntsville, Ala.
STS PROPELLANT SCAVENGING SYSTEM STUDY
M. A. Page 205-453-2817

Cryogenic orbit transfer vehicles (OTV) will require cryogenic propellants in space. A range of 4000 lbs. to 15,000 lbs. of residual propellants are available in the STS after main engine cutoff. These propellants are not being utilized and are currently being dumped overboard. Additional propellants could also be made available for on-orbit use since the nominal manifested Orbiter payloads are less than the STS 65,000 lbs. payload capability. The development of a cryogenic propellant scavenging technique for transferring unused propellants rom the STS would result in maximizing the STS capability for each mission and providing propellants for OTV usage. The propellants could be transferred directly from the STS to an OTV or to a tanker vehicle that delivers the propellants to a Space Station based cryogenic propellant storage facility. The first step in the development of a flight demonstration experiment to verify propellant scavening techniques is to perform a system study to establish the optimum system to be used. Currently several techniques have been proposed, however, no indepth analyses have been performed. The system study would produce comparative data on weight, system complexity, operational requirements, STS impacts, propellant availability and cost for the various proposed concepts. The results of the system study will establish the preferred design concept of a flight demonstration experiment.

W84-70729 **906-65-04**
Marshall Space Flight Center, Huntsville, Ala.
SDV/ADVANCED VEHICLES
M. A. Page 205-453-2817

The objectives of this effort are: to define vehicle concepts and supporting facilities/equipment definition for Shuttle Derived Vehicles; to establish and incorporate mission requirements into the basic vehicles definition; to establish methods of transporting propellant to an Orbiting Space Station and/or propellant holding tanks; and to determine costs, benefits, and schedules required for implementation. Contracted studies are currently in progress to define several Shuttle Derived Vehicle concepts that could augment the basic STS in several different ways. These concepts utilized current state-of-the-art technologies and the configurations were established by trade analysis. SDV concepts that are currently being investigated or have been investigated include: SRB-X, Shuttle Derived Cargo Vehicles (side-mount and in-line) and reusable liquid rocket boosters for use with the basic STS and/or Shuttle Derived Cargo Vehicles. Potential mission applications and benefits will be examined in more depth for selected vehicle concepts or classes in FY-84, along with further definition of the vehicle cncept(s), its capabilities, requirements for on-orbit propellant transportation, and requirements for implementation. Trade studies to determine the benefits of flyback boosters, in comparison with ballistic down-range recovery approach will be made. Cost and schedule estimates will be made in preparation for configuration trades and selection.

W84-70730 **906-75-10**
Marshall Space Flight Center, Huntsville, Ala.
LEO PLATFORM/REMOTE SERVICING
R. L. Middleton 205-453-2769

The objective of this study is to define the interface compatability factors between a manned space station, LEO platforms, and transfer vehicles. The ultimate design of each of these spacecraft must reflect a systmatic evaluation of their operating interfaces and the specific vehicle design requirements. This study will evaluate the interrelation between these vehicles considering benefits and operating mode requirements to define a set of design requirements for each vehicle. The approach will be to utilize existing design/studies of TMS, space station and LEO platforms to perform systems engineering analysis of servicing operation interrelation and recommend configuration details based on analysis and benefits.

W84-70731 **906-75-22**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL DEBRIS
A. E. Potter 713-483-5039

The population of orbital debris is growing, and according to model predictions, it may increase to levels which will require change in spacecraft design within a decade. The objective of this task is to define the current debris population and to forecast accurately its future growth, in order to permit timely adjustments to spacecraft design and operation. NORAD provides data for relatively large debris objects, which comprise only a part of the debris population. A major emphasis of this work is to obtain or infer information about small debris population (down to 1mm), and predict current and future probabilities for collisions of debris with spacecraft. Several avenues will be followed: First, some of the NORAD data is currently rejected. This data will be saved and analyzed. Second, the NORAD ground-based optical sensor (GEODSS) will be used to obtain data for small debris by operating at twilight, along with a meteor radar to distinguish slow meteors from orbiting debris. The radar will also be used to detect reentering debris. Third, the IRAS satellite will be used to measure the small debris population accessible to its sensors (pending IRAS program approval). Finally, existing laboratory data on small particle yields from explosions and hypervelocity collisions will be analyzed, and used to model the yield of debris from orbital explosions and collisions. In order to use all this new data effectively, the orbital debris model will be expanded and improved. Results will be used to forecast future trends of the orbital debris population.

W84-70732 **906-75-50**
Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE SERVICES
H. Benson 713-483-2263

This RTOP continues the development of satellite servicing capabilities and addresses the following areas: (1) improved cargo bay payload operations through the development of a versatile, reconfigurable 'carry-on' aft flight deck control station; (2) the development of a plan for the acquisition of identified satellite servicing needs in an orderly, cost effective manner; (3) the development planning for attaining a telepresence work station capability for cargo bay and later, remote operations; and (4) increased EVA effectiveness and efficiency through the reduction of prebreathe time. Specific tasks for FY 84 are: orbital payload work station system, satellite servicing program planning, teleoperator work station study and the zero prebreathe suit.

W84-70733 **906-90-03**
Marshall Space Flight Center, Huntsville, Ala.
GEOSTATIONARY PLATFORM
R. H. Durrett 205-453-3424

This RTOP is for the OSF portion of a joint OSF/OSSA program primarily to enable effective aggregation of space communication payloads to enhance the arc/spectrum resource and, secondarily, to pursue alternative ways to enhance STS operations at geo-synchronous orbit. The guiding overall NASA objectives of this program will be to ensure continued preeminence of the U.S. in

space technology and to fully exploit the STS. A four-phase program is to be pursued, with the OSF responsibility being in the bus/transportation and related space operations areas. The first phase will establish validity of payload aggregation, identify critical technologies, and identify and scope U.S. industry/NASA's role in enabling the required technology. The second phase will define industry/NASA roles, NASA's program content, and program resources required to establish enabling technology. Critical technology development will be initiated. The third phase will be design required experimental mission(s) and flight system(s) concepts necessary to establish enabling technologies. Proof-of-concept technology development will be completed. Finally, the fourth phase will be to develop experimental systems as required and to conduct experiment mission operations.

W84-70734 **906-90-15**

Marshall Space Flight Center, Huntsville, Ala.

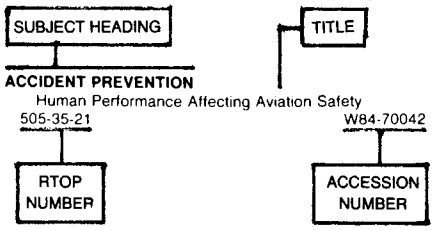
SPACE PLATFORM EXPENDABLES RESUPPLY

W. E. Thompson 205-453-2796

This multi-year program encompasses the definition, design, development and demonstration of a Resupply Module to provide remote fluid resupply services (propellants/pressurants/coolants) to future spacecraft/space platforms operating outside the range of the STS Orbiter. The OTV and TMS are candidate carrier vehicles for Resupply Module operations at GEO and various LEO altitudes. Systems analysis was initiated in FY-83 to establish preliminary resupply requirements for candidate user spacecraft, design concept, and preliminary supporting development programs. Results of the FY-83 task will provide recommended design concepts for spacecraft adaptations and Resupply Module including tankage/transfer systems and supporting mechanisms. These outputs will be utilized in FY-84/85 to provide system definition for remote fluid resupply. This effort will include parallel experiment definition of a candidate flight test for subsequent design and development.

SUBJECT INDEX

Typical Subject Index Listing



A title is used to provide a more exact description of the subject matter. The RTOP accession number is used to locate the bibliographic citations and technical summaries in the Summary Section.

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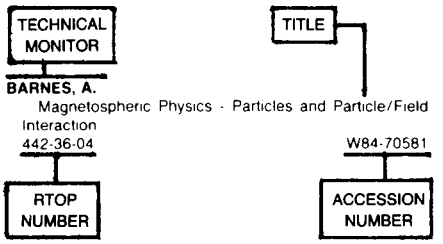
TECHNICAL MONITOR INDEX

RTOP SUMMARY

FISCAL YEAR 1984

Typical Monitor Index Listing



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ABBOTT, M. R.
Studies of Ocean Productivity
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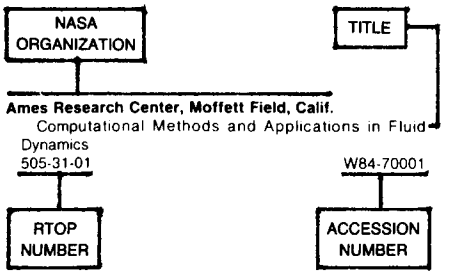

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16. Abstract

This publication represents the NASA research and technology program for FY 1983. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. The first section containing citations and abstracts of the RTOPs is followed by four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

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